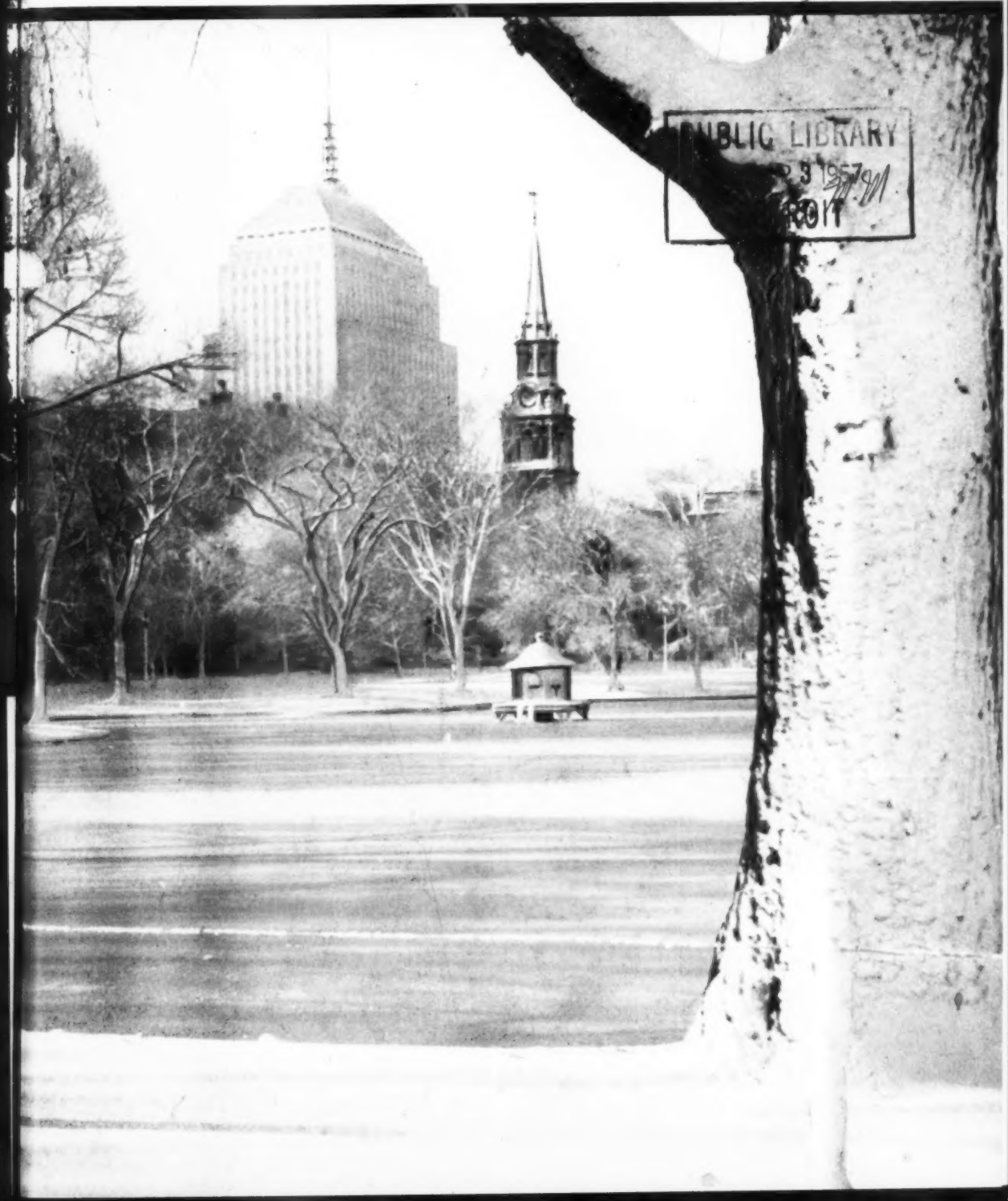
TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

January 1957

vol 59 # 3



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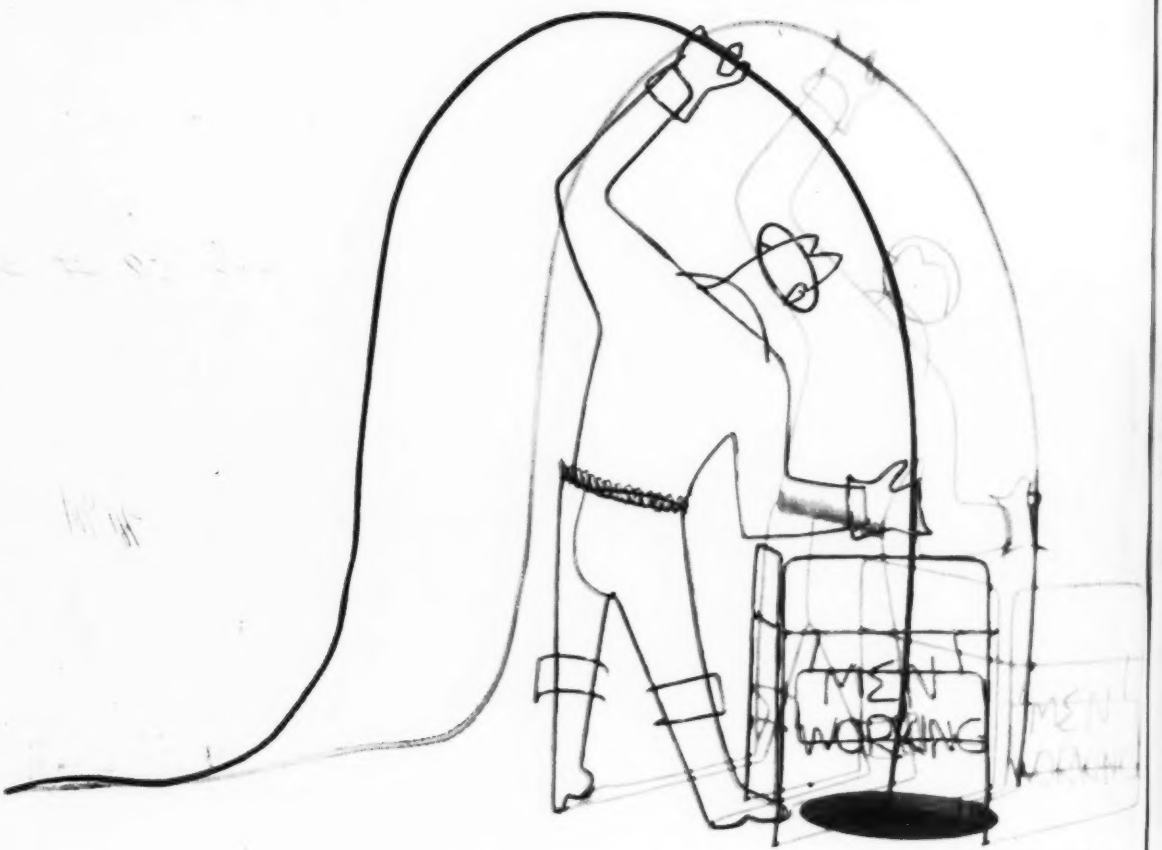

Wire sculpture by Henry Szafarz

The Inside Story

Beneath the surface, there's a lot going on.

An underground river of power surges through innumerable cables, supplying the electrical energy that keeps the entire community rolling smoothly.

Throughout the nation, Simplex products are used extensively in such applications. This is particularly true of ANHYDREX XX, the ideal all-purpose cable for high-voltage use. This expertly engineered cable is popularly employed in the 2001 to 35,000 volt range, and has a Conductor Temperature Rating of 90°C up to 5 KV (a rating never attained before the development of ANHYDREX XX).

For more technical data, write for Booklet 1023.

SIMPLEX WIRE & CABLE CO., 79 Sidney Street, Cambridge 39, Mass.

Simplex Anhydrex XX Underground Cable

Simplex

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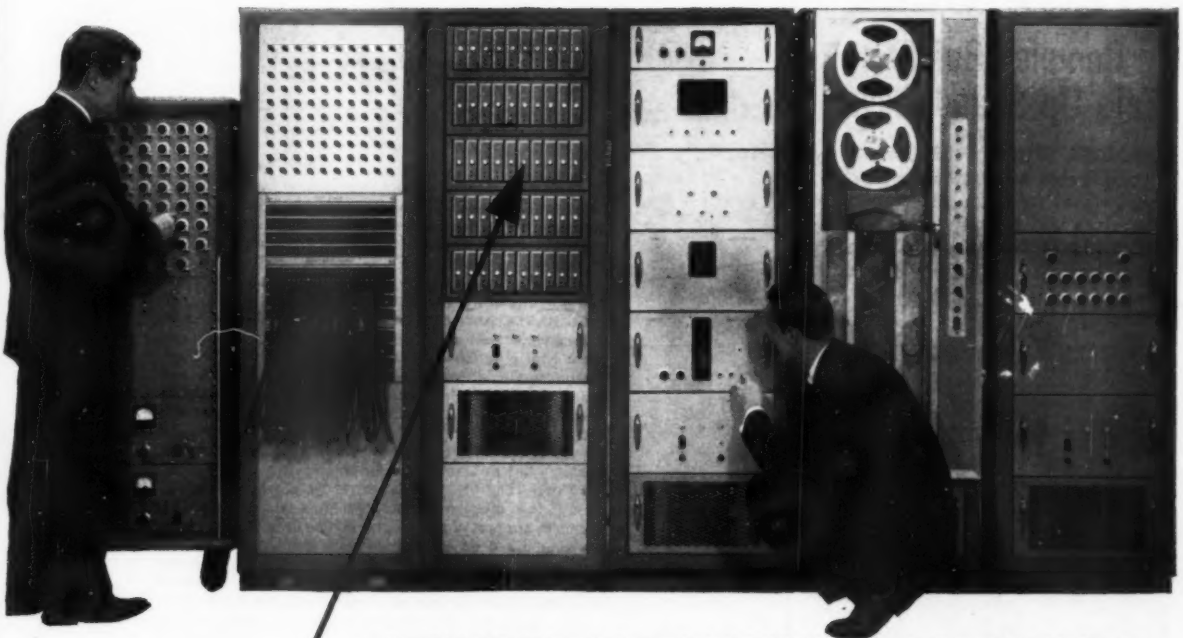
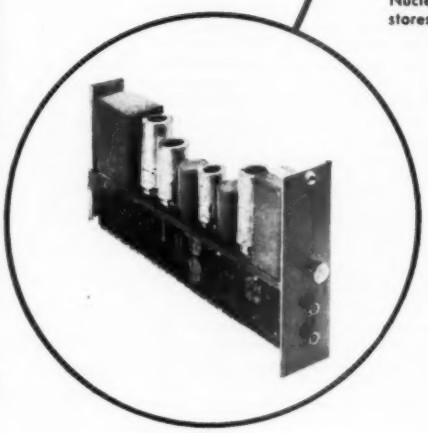
Doelcam Preamplifiers combine isolated input with accuracy of 1 part in 2,000 in the CEC MilliSADIC



Consolidated Electrodynamic Corporation's MilliSADIC Installation for General Electric's Aircraft Nuclear Propulsion Dept., Cincinnati samples 400 jet engine temperatures per second and stores this information in digital form.



Doelcam Data Handling D-C Amplifier, Model 2HDH-2. This type is used as preamplifiers in the CEC MilliSADIC shown above.

The *isolated input* of the Doelcam Data Handling D-C Amplifiers, Model 2HDH-2 makes them ideally suited as preamplifiers to raise the input signals from thermocouples and strain gauges to the level required by the analog-to-digital conversion system of CEC's MilliSADIC installation at General Electric's Aircraft Nuclear Propulsion Dept., Cincinnati. The low noise level, high degree of linearity and zero and gain stability of these amplifiers provide the accuracy of 1 part in 2,000 required for this application. The exclusive Doelcam Second Harmonic Converter as the input element of these amplifiers provides the bonus features of ultra high common mode rejection and resistance to pick-up.

Doelcam Data Handling D-C Amplifiers, 2HDH Series, are compact plug-in, rack-mounted units specifically designed for use as preamplifiers in data processing systems. These amplifiers are available in the input range, rise time, frequency response or gain specifications required by many data processing systems. Other amplifiers in this series can accept as many as 150 separate D-C signals per second. Write for Bulletin 2HDH . . . Doelcam, Dept. 1, a Division of Minneapolis-Honeywell, 1400 Soldiers Field Road, Boston 35, Mass.

Honeywell H HONEYWELL

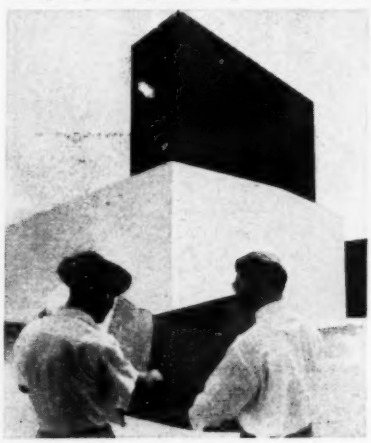
DOELCAM DIVISION

THE TECHNOLOGY REVIEW, January, 1957, Vol. LIX. No. 3. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $4.00; Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

NORTHROP ENGINE TEST CELL

Complex Building Eats Up Sound Waves

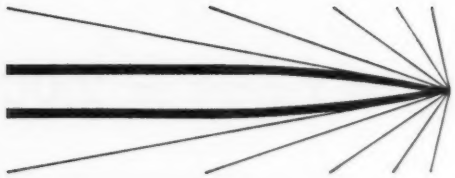
(HAWTHORNE, CALIF.) In this apparently uncomplicated structure, shown below, sound waves from the most powerful jet engines will literally destroy themselves. It is Northrop Aircraft's uniquely designed engine test cell,



which is actually two buildings — one within the other — and the inner one is divided into four separate sections. Each unit is completely insulated from the others to add to the destruction of all sound. An entire fuselage of Northrop's Snark SM-62 missile can be placed in the forward section of the cell, yet little if any sound from its powerful engine can be heard outside.

Sound from the engine under test passes into a maze of concrete chambers which produce resonances destructive to the sound itself. Northrop missile engineers will be completely isolated from any sound during the tests, which can be observed through a closed television circuit. Two sets of 18-ton doors, that hermetically seal the building during tests, can be closed in 30 seconds by small air motors. The cell also has a three-fold fire prevention system to eliminate all fire danger.

The new building is one of many advanced features incorporated in Northrop's multi-million-dollar engineering and science center. When completed, this center will offer engineers the opportunity to work with the latest equipment and installations in the most advanced facility of its kind.



MISSILE ENGINEERS

Many new positions are being created at Northrop Aircraft for missile engineers in a wide range of activity: control, guidance, servo, computers, recording, optical, reliability, electro-mechanical, telemetering and electronics. There's an interesting position for you, at your own experience level, with attractive remuneration and steady advancement, in one of the following groups:

GUIDANCE AND CONTROLS, encompassing research and development of advance automatic guidance and flight control systems for both missiles and piloted aircraft. Specific areas of development include: radio and radar systems, flight control systems, inertial guidance systems, instrument servo systems, digital computer and magnetic tape recording systems, airborne analogue computer systems, optical and mechanical systems, and systems test and analyzer equipment.

FLIGHT TEST ENGINEERING SECTION, which plans the missile test programs and establishes test data requirements in support of the programs. The data requirements are predicated on the test information required by the engineering analytical and design groups to develop and demonstrate the final missile design, and are the basis from which instrumentation requirements are formulated.

The analysis work performed consists of aerodynamic, missile systems, dynamics, flight control, propulsion and guidance evaluation. The Flight Test Engineering Section is also responsible for the field test program of the ground support equipment required for the missile.

FLIGHT TEST INSTRUMENTATION SECTION, which includes a Systems Engineering Group responsible for the system design concept; a Development Laboratory where electronic and electro-mechanical systems and components are developed; an Instrumentation Design Group for the detail design of test instrumentation components and systems; a Mechanic Laboratory where the instrumentation hardware is fabricated; and a Calibration and Test Group where the various instrumentation items and systems are calibrated and tested.

For 17 years Northrop Aircraft has pioneered in missile research and development. As a member of this forefront organization in this growing field, new opportunities for full expression of your initiative and ability will always be yours at Northrop.

If you qualify for any of these attractive positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., telephone ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600-88, Hawthorne, California.

NORTHROP

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

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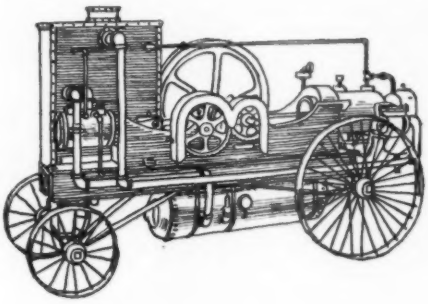
55 YEARS AGO

this early portable compressor made air power history



THIS gasoline-powered portable air compressor, introduced by Ingersoll-Rand in 1902, may look crude and cumbersome by today's standards. But at the time it was a real innovation — one of the first practical compressors which could be easily moved about from job to job.

TODAY *it's the* GYRO-FLO

. . . another basic advance in compressor design by Ingersoll-Rand

THE GYRO-FLO is a rotary sliding-vane portable compressor with oil injection cooling, first introduced by Ingersoll-Rand in 1950. The success of this unit has been proven by the ever-growing trend to this type of design, and the increasing demand for rotary air power. Ingersoll-Rand now manufactures the most complete line of rotary portable compressors available.

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Harold Hindman '39 II *George Burr '41 VIII*

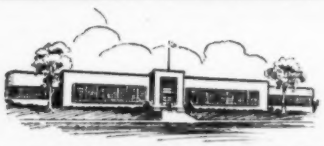
THE TABULAR VIEW

Uncommon Man. – So much of Twentieth Century thinking extols the virtues of the masses that we tend to become oblivious to the consequences of leveling processes that inevitably ensue by catering to the common man. For this reason, "Education of the Uncommon Man" (page 149) by EDWIN S. BURDELL, '20, comes as a breath of much needed fresh air. Dr. Burdell holds that society should be as much concerned with the advancement of the uncommon man of brains and integrity as it has been with enlightenment of the masses. Dr. Burdell's message in The Review is abstracted from his annual report as President of the Cooper Union for the Advancement of Science and Art.

President Burdell studied at M.I.T. and Harvard as a member of the Classes of 1920 and 1921, respectively. In addition, he received the A.M. and Ph.D. degrees from Ohio State University in 1929 and 1934, respectively. He was a faculty member at Ohio State University from 1928 to 1934; member of the Ohio Commission on Unemployment Insurance, 1932; state administrator for Emergency Education in Ohio, 1933-1934; professor of sociology and director of summer school, M.I.T., 1934-1938; Dean of Humanities, 1937-1938 at M.I.T.; and, since 1951, has been president of Cooper Union. He headed a Committee on General Education of the American Society for Engineering Education, and his chief interests include city planning and social interpretation of the impact of techology on modern society.

Technical Man Power. – In an address before the M.I.T. Club of New York on November 14, PRESIDENT JAMES R. KILLIAN JR., '26, spoke on the need for increasing our available supply of scientific and engineering man power. But Dr. Killian also recognized that, however great may be the need for technical man power, our top priority is to develop the nation's intellectual potential to the fullest. "Scientific and Engineering Man Power" (page 152) is a report and condensation of this outstanding address. President Killian has to his credit a distinguished list of achievements as educator, administrator, author, and public servant.

(*Concluded on page 134*)



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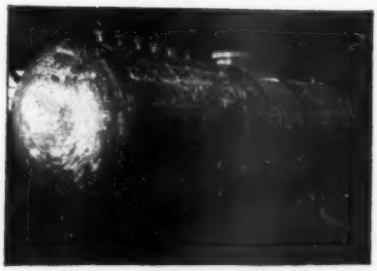

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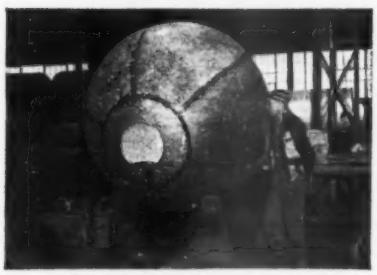
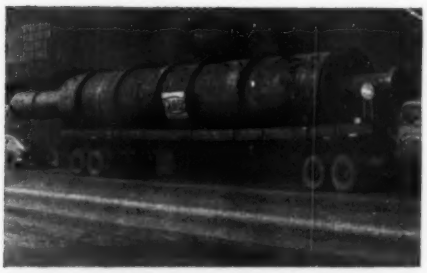


Solid stainless sphere for gas



Stainless-clad vacuum column

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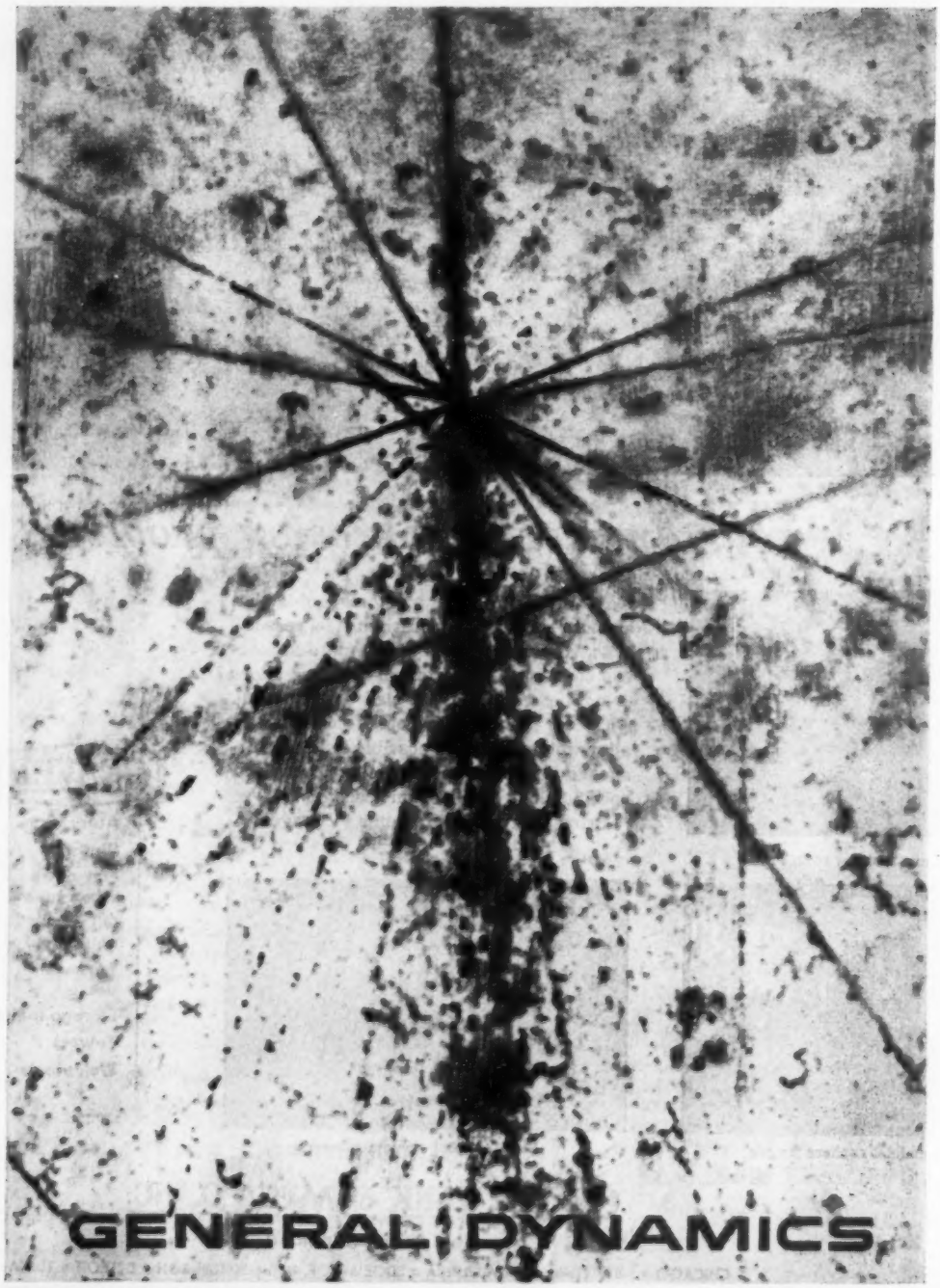
Exploring the Universe: Sub-Atomic Worlds. . . . To Greeks, the atom was literally "a-tomos," not to be cut. Now its very nucleus is split and scientists are tracking *sub-atomic* particles, seeking to discover the nature—order and meaning—of a vast, dynamic universe in which domestic notions of space and time and energy do not apply. *Ethical corollary:* The "finds" of nuclear exploration must be employed *not* in the service of a scientific, or economic, or political provincialism but *wherever* they are needful to the physical, mental and moral rehabilitation of men and of societies.



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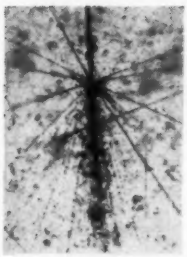

"Within the next century, all the world will be poor in energy ...except for atomic energy."

Can we say then—since there is a positive correlation between energy consumption and national income, and between national income and individual living standards—that many of today's children may see, and suffer from a world-wide poverty?

The industrial West—metallurgy, combustion engines, chemistry, steam, electricity, electronics—was built and is maintained by *power* derived from fossil fuels. It is a "coal and oil" civilization and it, alone, in the next century could consume all the free world's coal and oil resources.

Now, however, the once-agrarian East and Latin America—two-thirds of the world's population—also are determined to have the benefits of industrialization: *power* to conquer poverty and disease; *power* to create and maintain an economic self-sufficiency; and, out of that, *power* to create and maintain political freedom.

The practical developments of the Industrial Revolution that have so profoundly changed the world economy since 1856 — the Bessemer converter, aniline dyes, oil-cracking, the internal combustion engine, the electric motor, electric light, electric power, synthetics, electric and electronic communication, automation and computation, the submarine, winged and wingless aircraft and the space rocket—were the direct result of preceding theoretical explorations by Galileo, Bacon, Newton, Gauss, Laplace, Faraday and those others who could visualize new worlds.

the view from 100 years

The Atomic Revolution now overthrowing present conceptions of power, transport, communication, medicine, agriculture and biology—and hence colonial and collectivist politics—stems directly from the pure and applied scientific research of Curie, Rutherford, Planck, Einstein, Bohr, Fermi, and hundreds of others.

It is evident, then, that *exploration of the universe* is now requisite to our survival as men and nations.

Thus, prospecting for new energy sources — whether in sub-atomic worlds, in the atom, in the earth, in the sea, in the sun, or in the dynamics of stars—is an enterprise for new *scientist-manager-engineer-share owner* groups. Corporate "systems" with the research and development capabilities, the production facilities, the financial capacity and the courage to fit out scientific expeditions to new and far places — and to capitalize on their discoveries.

General Dynamics today is the product not only of its own particular history but of the scientific and industrial history of the Western world. As such, Dynamics declares its corporate purpose to be:

The comprehensive exploration and translation of the basic forces of nature into useful work under the sea, on the sea, on land, in the air, and in space beyond the earth's atmosphere.

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You and we can form a team—you to draw up the specifications; we to make the gears—that will be profitable to both of us. Gears of all types, all sizes, all materials. Design-engineering service available.

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THE TABULAR VIEW

(*Concluded from page 130*)

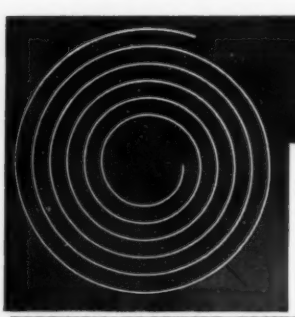
Earnest Encomium. — CRAWFORD H. GREENEWALT, '22, President of the E. I. du Pont de Nemours and Company, and long-time friend of Alfred P. Sloan, Jr., '95, was charged with making the presentation to Mr. Sloan, of the Silver Stein Award of the M.I.T. Club of New York on November 14. In his tribute to Mr. Sloan (page 154) as a public-spirited citizen, Mr. Greenewalt clearly recognizes that as government "must tailor its program to the general level, to the common denominator" and that "as opportunities for private generosity are gradually worn away, we face . . . the possibility that our moral and spiritual standards will be subjected to a similar erosion."

Mr. Greenewalt has been associated with the Du Pont firm since his graduation from M.I.T. in 1922. His rise has been steady, and he became Du Pont's 10th president in January, 1948. He made notable contributions to the successful construction and operation of the Hanford plant of the Atomic Energy Commission during World War II. He has been awarded half a dozen honorary degrees, is a life member of the M.I.T. Corporation, and is affiliated with many scientific societies.

Rational Response. — In responding to the award of the Silver Stein presented to him on November 14 by the M.I.T. Club of New York, ALFRED P. SLOAN, JR., '95, observed (page 155), "What better investment can we, as a people, make than in education?" M.I.T. awarded Mr. Sloan an S.B. degree, and Princeton University conferred upon him the LL.D. degree.

Mr. Sloan was president and general manager of Hyatt Roller Bearing Company for 15 years, president of United Motors Corporation for three years, president of General Motors Corporation 14 years and, from 1937 until recently, chairman of its board of directors. At present, Mr. Sloan is honorary chairman of General Motors Corporation. He is also director of E. I. du Pont de Nemours and Company.

Graft Inquiry. — FREDERIC W. NORDSIEK, '31, frequent contributor and valued editorial associate of The Review since 1944, finds himself involved in an inquiry of graft this month (page 156), but the graft is of the horticultural or medical variety and bears not on ethics. Since his graduation from the Institute's Course in Biology and Public Health in 1931, Mr. Nordsiek has had a varied and interesting professional career in the food industry or in public health. For the past several years he has been engaged in administering research grants for the American Cancer Society.



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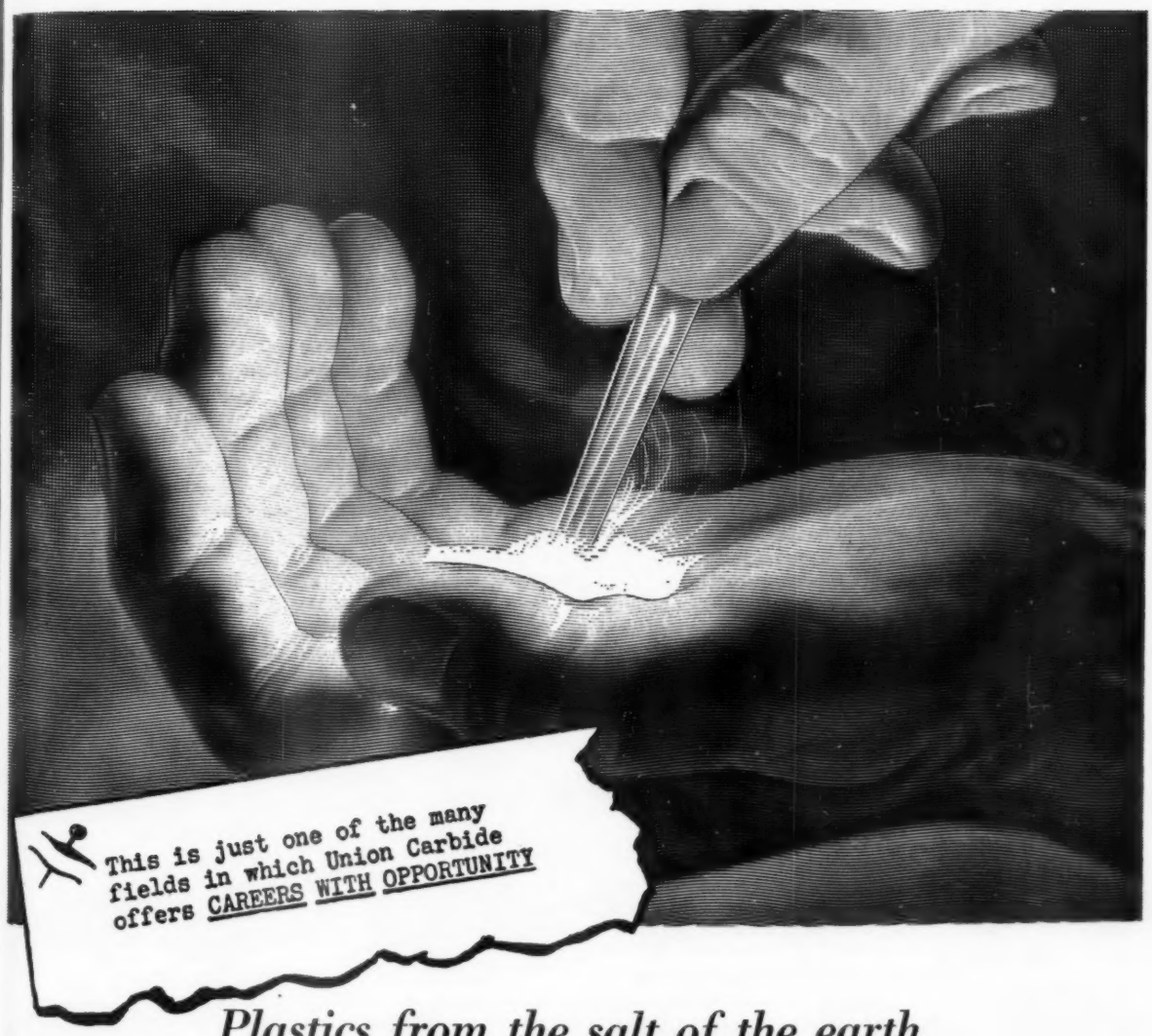

Plastics from the salt of the earth

WITH THE PAINSTAKING care of expert chefs, scientists combine ingredients from salt and natural gas—cook them in huge pressure cookers called autoclaves—and turn out amazing vinyl plastics.

First to use the recipe over 25 years ago, the people of Union Carbide prepare millions of pounds of vinyl plastics each year. They can be blended into materials that ignore scuffing . . . stay young and flexible for years . . . thrive in sunlight or salt water . . . and shrug off liquids known for staining.

As flexible film, vinyls become decorative shower curtains, draperies, protective garment bags, or inflatable toys. Vinyls can be squeezed through a hole—like toothpaste from a tube—to make insulation for wire and cable. Other forms produce wear-resistant flooring, durable upholstery, washable playing cards, unbreakable phonograph records. The list of useful products grows bigger all the time.

With an eye to the future, the people of Union Carbide are still pioneering in this fascinating field. The years to come will see more and better plastics serving in every American home.

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Amund Enger, '27

Summer in Norway

Technology Review

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Edited at the Massachusetts Institute of Technology

VOL. 59, NO. 3 JANUARY, 1957

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Photograph by Raymond E. Hanson

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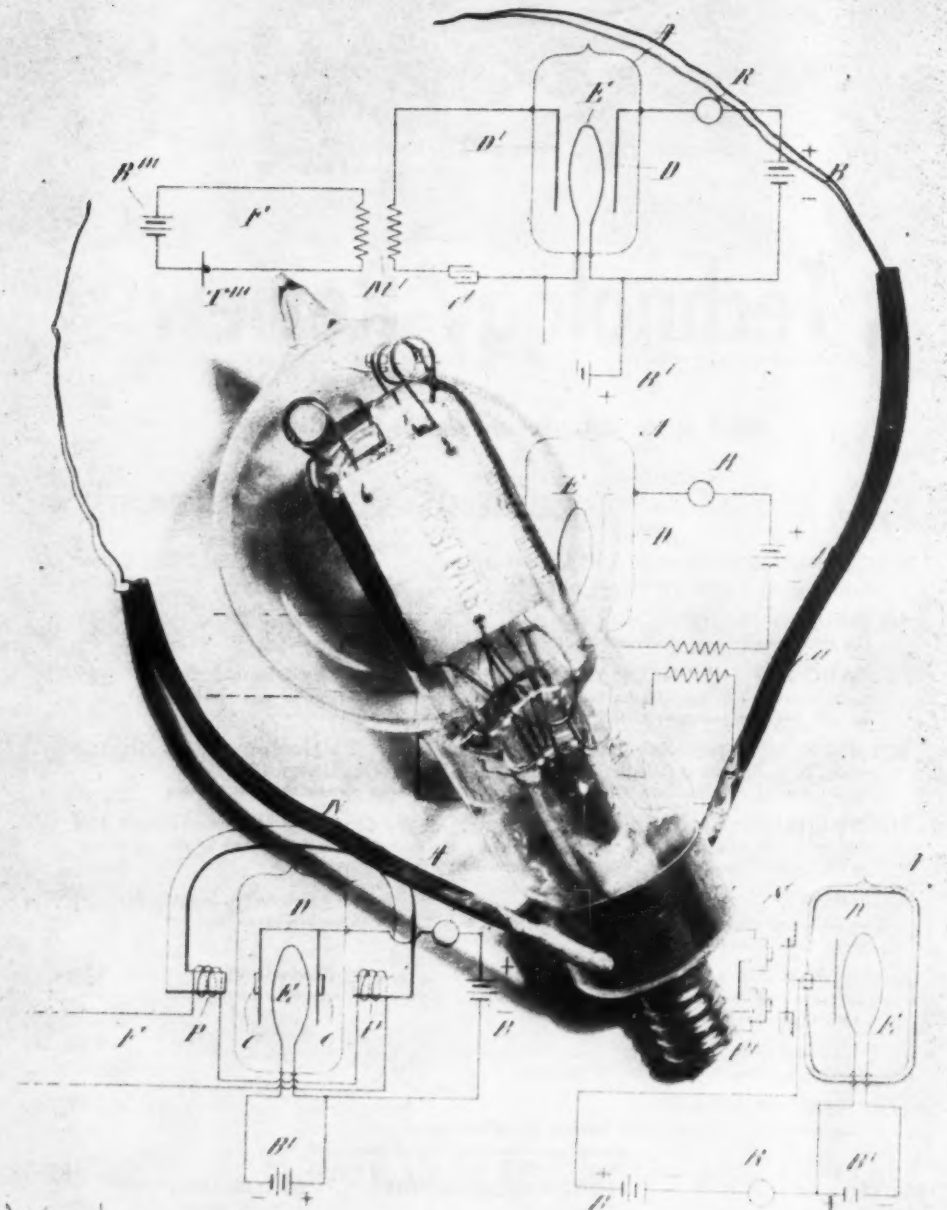
No. 841,387. PATENTED JAN. 15, 1907.

L. DE FOREST.

DEVICE FOR AMPLIFYING FEEBLE ELECTRICAL CURRENTS.

APPLICATION FILED OCT. 25, 1906.

2 SHEETS--SHEET 2.



WITNESSES:
E. B. Stimpson
Patrick J. Conroy

Fig. 6

Fig. 7. INVENTOR
Lee de Forest
by Geo. K. Woodworth
Attorney

An Industry Is Born

With a half century of significant developments to its credit, the electronics industry can trace its origin to the invention of the Audion by Lee DeForest in the latter half of 1906, and particularly to the patent, issued January 15, 1907, for a "device for amplifying feeble electrical currents."

The Technology Review

VOL. 59, No. 3 JANUARY, 1957

The Trend of Affairs

Half a Century of Electronics

■ This month marks the 50th anniversary of the issuance of the famous patent No. 841,387 on the first electronic "device for amplifying feeble electrical currents." Its inventor, Lee DeForest, called the new device the "audion," since, he said, one could hear the ions within the tube. With the mushrooming of radio broadcasting, in the early 1920's, we have become so accustomed to the use of electron tubes in our homes, and to the versatility of electronic controls in industry and in national defense, that it is difficult to recapture the limitations of the "pre-electronic" era and to recognize the technological importance of adding two simple electrodes to Edison's incandescent lamp, then a quarter century old.

Prior to the invention of the three-element amplifying electron tube by DeForest, long-distance telephone communication was limited to ranges of perhaps 100 miles or so; for the mechanical repeaters antedating the electron tube were not very satisfactory. Radio telephony had been demonstrated prior to the invention of the audion, but only with relatively cumbersome arcs or rotating machinery that lacked flexibility and effective modulation control. The principles of television had been worked out, on paper, but only the most crude and unsatisfactory form of visual communication could be evolved without the use of electron tubes. Control and measuring devices of previously unheard of flexibility, versatility, and sensitivity became possible with the invention of the electron tube.

In 1883, Edison had discovered that an electric current would flow between an incandescent filament and a plate sealed within his lamp, if the plate were maintained at positive potential with respect to the heated wire. Such a device served as a unidirectional current control, or rectifier, and was so used by Sir John Ambrose Fleming in radio reception, about 1904. By interposing a gridlike conductor between filament and plate, DeForest found his audion would act as an amplifier, as well as a rectifier. Half a century ago, limitations of vacuum-pumping technique made it difficult to produce audions that were entirely free from gas and, for several years, arguments raged as to the part gas played in such a tube.

DeForest's invention was a simple thing, yet it had profound effects on the electrical engineering industry. Our present multi-billion dollar electronic industry is built on electron flow control, first put to practical use in DeForest's audion. The basic three-electrode tube of DeForest has now grown into a colony of many different kinds of electronic control devices, including new types – transistors – that have joined in the service to mankind in the past decade.

By 1915, less than 10 years after the first three-electrode tube had been made, telephone service had been extended across the United States, and radio telephone signals from Washington, D. C. were heard simultaneously in Paris and Honolulu.

The electron tube made possible radio broadcasting in the early 1920's, electronic hearing aids in the 1930's, black and white television in the 1940's, color television in the 1950's, and radar techniques developed during World War II.

In September, 1956, service was opened on the first transatlantic telephone cable, using hundreds of electron tube repeaters or amplifying devices laid on the floor of the ocean where they are expected to function perfectly, even though unattended, for some 20 years.

Three distinct properties were responsible for the importance of the three-element electron tube. First and most important of all, the tube could be made to amplify signals applied to its grid, the magnified output being taken from a separate plate circuit. The grid could be maintained at a negative potential while still effecting control and, when so operated, took no power from the control circuit operating the tube. Finally, because the grid was able to control the flow of the smallest carriers of electricity – electrons – it was able to operate faster and upon much more complex wave forms than had previously been possible. In the light of present-day technology, these achievements are taken for granted, but 50 years ago their satisfactory accomplishment was little short of miraculous.

Family Tradition

■ Of the entering classes this fall, of exactly 6,000 students, the Freshman Class of 936 includes 28 young men whose fathers preceded them in becoming Technology Alumni. Six freshmen have fathers who are members of the Class of 1929, four claim indirect affiliation with the Class of 1931, and three freshmen are sons of members of the Class of 1923. The Classes of 1928 and 1932 swell this year's freshman enrollment with two members each. Oldest and youngest classes to be represented in "following father's footsteps" are those of 1918 and 1940, respectively.

Freshmen who entered Technology last September, along with their father's name and class affiliation, are:

Student	*Parent*
Griffin Y. Anderson	George Y. Anderson, Jr., '24
George F. Badger	George F. Badger, '29
Norman A. Ball	Norman H. Ball, '29
William J. Bissen	Reginald A. Bissen, '30
Jonathan W. Bulkley	Reginald W. Bulkley, '27 (Deceased)
Richard F. Cahaly	Fozi M. Cahaly, '33
Donald F. de Reynier	Pierre F. de Reynier, '23
Bruce R. DeYoung	Russell DeYoung, '40
Richard G. Everit	Richard S. Everit, '19 (Deceased)
Willard B. Foster	Willard H. Foster, '32
Malcolm D. Fraser	Donald S. Fraser, '28
Phillip F. Frink, Jr.	Phillip F. Frink, '31
Walter Godchaux, 3d	Walter Godchaux, Jr., '35
Loren Godfrey	Edward R. Godfrey, Jr., '29
Joseph L. Johnson, Jr.	Joseph L. Johnson, '38
Frederick A. Kinch, Jr.	Frederick Kinch, '23
George L. Kirk	William J. Kirk, '28
Roger G. Mark	Jacob G. Mark, '29
Gerald R. McCulloh	Carroll D. McCulloh, '31
George J. Meyers, 3d	George J. Meyers, Jr., '29
James W. Overbeck	Wilcox P. Overbeck, '34
Richard L. Pack	Mendel N. Pack, '31 (Deceased)
James C. Pennypacker	James Pennypacker, '23
Richard V. Rossman	Edwin F. Rossman, '18
Douglas C. Sinclair	Donald B. Sinclair, '31
Jason L. Speyer	Joseph L. Speyer, '29
Norman Vadner	Lawrence S. Vadner, '22
Lawrence F. Wagner	Lawrence F. Wagner, '32

Of the 6,000 students currently enrolled at the campus on the Charles, 2,312 (or 38.5 per cent) are registered as graduate students. The remaining 3,688 undergraduates are approximately equally divided among the four classes with 936 freshman, 931 sophomores, 923 juniors, and 898 seniors (including fifth-year students in Architecture).

Statistically minded readers will be interested to know that the Department of Electrical Engineering has the largest total enrollment with 1,294 students at all levels. It has also the largest graduate enrollment with 407 students. The Department of Physics, with 693 students enrolled, of whom 180 are graduates, ranks second. The Department of Chemical Engineering has the third largest enrollment with a total student body of 656 including 234 graduate students. The Department of Mechanical Engineering, with 631 students (including 207 in the Graduate School) ranks fourth.

Rabi Is Institute Professor

■ Isidor I. Rabi, Higgins Professor of Physics at Columbia University and one of the nation's most distinguished physical scientists, is visiting Institute professor at M.I.T. during the current fall term. The Institute professorship was established especially to permit men of highest achievement to study and teach at M.I.T. in fields of their own interest, without the restrictions of traditional departmental boundaries.

His appointment was recently announced by Chancellor Julius A. Stratton, '23, who said:

> We are especially honored that Dr. Rabi's broad experience and distinguished talents may be shared with the Faculty of our School of Science. He is a scientist of very great accomplishments, and we hope that this Faculty post, leaving him free to cut across all established lines of scientific disciplines, will prove a stimulating and profitable one.

Winner of the Nobel Prize in physics in 1944, Dr. Rabi is widely known for his research in nuclear physics as well as for many activities in bringing science to serve national defense. His Nobel Prize was awarded for pioneering studies of the magnetic moment of the atomic nucleus, and he has made many other research contributions to quantum mechanics and theoretical physics.

Dr. Rabi holds degrees from Cornell and Columbia Universities, and he studied extensively in Europe before joining the staff at Columbia in 1929; he has been professor of physics there since 1937. He is chairman of the Scientific Advisory Committee to the Office of Defense Mobilization, a member of the Naval Research Advisory Committee, and U. S. representative to the United Nations Committee on the Conference for the Peaceful Uses of Atomic Energy. Among many awards have been the Sigma Xi Semicentennial Prize (1936), the Medal for Merit, the Legion of Honor (France), and the King's Medal (Great Britain).

No stranger to M.I.T, Dr. Rabi was associate director of the Radiation Laboratory here from 1940 to 1946. Beginning with his chairmanship of the committee to study early performance reports of radar equipment on the front lines, Dr. Rabi was a key man in the laboratory's administration and a member of its Steering Committee.

Briton Speaks on Middle East

■ A former British Middle East political officer, a long-time government servant of Great Britain, recently spoke at M.I.T. on "British Policy in the Middle East." The speaker was John H. Peck, C.M.G., Director-General of the British Information Services, New York. His public lecture, sponsored by the Political Science Section in M.I.T.'s Department of Economics, was held on Friday, November 16, in the Library Lounge of the Hayden Library Building.

Mr. Peck was a member of Winston Churchill's personal staff throughout Mr. Churchill's service as Prime Minister during World War II. Later, from 1954 to 1956, he was head of the Political Division of the British Middle East Office where his principal task was political liaison with land and air headquarters of the Middle East Forces.

Biophysics Consultant

■ Richard H. Bolt, Professor of Acoustics in the Department of Electrical Engineering, and Director of the M.I.T. Acoustics Laboratory, has been granted a year's leave of absence to assist the National Institutes of Health in expanding its program for the sponsorship of biophysical science. Dr. Bolt will work with the Study Section on Biophysics and Biophysical Chemistry of the National Institutes of Health, U. S. Public Health Service, under an appointment as principal consultant. His office will be at M.I.T.

As professor of acoustics on leave, he will resign from the directorship of the Acoustics Laboratory, and administrative responsibility for the Institute's research in acoustics will be vested in the Department of Electrical Engineering.

In commenting on Dr. Bolt's new assignment, Francis O. Schmitt, Institute Professor of Biology and chairman of the Study Section, said:

"In this key position as principal consultant to the Study Section on Biophysics and Biophysical Chemistry of the National Institutes of Health, Dr. Bolt will be responsible for the planning and co-ordination of a new program aimed at the stimulation and development of the rapidly growing field of biophysics on a national scale.

"The application of the physical and engineering sciences to the investigation of the life sciences," Dr. Schmitt added, "is opening up ever-expanding horizons in biomedical research. Sensitive to the opportunities which this situation offers in the research and training program of the National Institutes of Health, this federal agency has recently placed substantial funds at the disposal of the Study Section with which to stimulate research and training in biophysics.

"This action represents a challenging opportunity to channel a significant fraction of the rapidly increasing federal funds for medical research into this field. Working with the Study Section as its chief executive and planning officer, Dr. Bolt will be concerned with the stimulation of teaching and research in biophysics and with the interchange of ideas and information on an interdisciplinary basis."

Professor Bolt brings to this program a wide range of relevant experience. During World War II, he served as scientific liaison officer for the Office of Scientific Research and Development in London and later as a chief technical aide of the National Defense Research Committee. As a member of the American Institute of Physics Policy Committee, he was chairman of the committee that developed the publication *Physics Today*. He has been president of the Acoustical Society of America and chairman of the Joint Armed Forces — National Research Council Committee on Hearing and Bioacoustics. Professor Bolt has been at M.I.T. since 1945.

Dr. Bolt is president of the International Commission on Acoustics and was chairman of the organization of the International Congress on Acoustics that was held at M.I.T. and Harvard last June. He is also currently a member of the Advisory Panel on Medical Sciences for the Secretary of Defense.

On the Horizon

January 30, 1957 — Midwinter Meeting of the Alumni Association. Walker Memorial, M.I.T. Campus. (Dinner 6:00 P.M. Reservations should be made through Alumni Office, Room 1-280, M.I.T.)

February 2, 1957 — 9th M.I.T. Alumni Regional Conference, Tulsa, Okla. Theme: "Conference on Engineering and Science — M.I.T.'s Salute to Oklahoma's Golden Jubilee." **Speakers:** President Killian; Deans E. P. Brooks, '17, and George R. Harrison; Professors Warren K. Lewis, '05, Robert R. Shrock, John G. Trump, '33, and Jerrold R. Zacharias. (Fur further information, consult Barrett B. Russell, 3d, '43, E. I. du Pont de Nemours and Company, 1811 South Baltimore Avenue, Tulsa 19, Okla.)

February 16, 1957 — 10th M.I.T. Alumni Regional Conference, Chicago, Ill. **Speakers:** President Killian; Deans E. P. Brooks, '17, and Pietro Belluschi; Professors Walter G. Whitman, '17, and John E. Arnold, '40. (For further information, consult John R. Kirkpatrick, '48, Arthur D. Little, Inc., 9 South Clinton Street, Chicago 6, Ill.

February 22-25, 1957 — "M.I.T. Week End in Havana," M.I.T. Club of Cuba. (For reservations, consult Antonio Helier Rodríguez, '21, Concordia 61, Havana, Cuba.)

March 14-16, 1957 — 9th Annual Fiesta, M.I.T. Club of Mexico, Mexico City, D.F. (For reservations consult Clarence M. Cornish, '24, Margaritas 139, Villa Obregon, Mexico 20, D.F., Mexico.)

June 10, 1957 — 23d Alumni Day, 1957, M.I.T. Campus in Cambridge.

Derwent Whittlesey: 1890–1956

■ Derwent Whittlesey, Visiting Professor of Economics in M.I.T.'s Department of Economics and Social Science, died at the New England Deaconess Hospital on November 25, 1956.

Dr. Whittlesey, who had been professor of geography at Harvard University since 1928, came to M.I.T. in September to give a new graduate seminar on strategic and political geography, a field in which he was an internationally known authority. Author, historian, and traveler-researcher, he also served as consultant to the U.S. Government during World War II and was a member of the National Research Council for 13 years.

A native of Pecatonica, Ill., Dr. Whittlesey received his bachelor's, master's, and doctor's degrees at the University of Chicago and held honorary degrees from Harvard University and Beloit College. He served on the faculties of Denison University and the University of Chicago before his appointment to Harvard, where he became full professor in 1943. Dr. Whittlesey was an honorary fellow and gold medalist of the Chicago Geographical Society, and a fellow of the American Academy of Arts and Sciences.

Individuals Noteworthy

■ Prominent in late autumn's news were 17 promotions, elections, or appointments as set forth below:

Franklyn M. Stibbs, '11, as a Director of the Connecticut Building Congress, Inc. . . . *Joseph W. Barker, '16,* retiring President of the American Society of Mechanical Engineers, as President of the Engineers Joint Council . . . *Robert E. Wilson, '16,* as a member of the General Advisory Committee of the Atomic Energy Commission . . .

E. P. Brooks, '17, as Director of the American Management Association . . . *Robert S. Mulliken, '17,* to the Ernest Dewitt Burton distinguished service professorship of the University of Chicago . . . *David P. Brown, '20,* as Treasurer of the Society of Naval Architects and Marine Engineers . . .

Edwin S. Burdell, '20, as chairman of the Coast Guard Academy Advisory Committee . . . *Augustus B. Kinzel, '21,* as President of the American Institute of Mining, Metallurgical, and Petroleum Engineers . . . *F. Marion Banks, '22,* as a Director of Servomechanisms, Inc. . . .

Rodolphus K. Turner, '23, as Vice-president of Carbide and Carbon Chemicals Company . . . *Arthur E. Benson, '26,* as development manager of the International Division, United States Rubber Company . . . *William C. Sessions, '26,* as Vice-president, Board of Trustees, Cleveland Health Museum.

Marshall W. Jennison, '27, as chairman of the Department of Plant Sciences, Syracuse University . . . *Frank C. Staples, '27,* as President and Vice-chairman of the American Molasses Company . . . *Russell C. Taylor, '27,* as a Director of A.C.F. Industries, Inc. . . .

William V. Goodhue, '39, as Director of Research and Engineering, Universal Winding Company . . . *Francis W. Sargent, '39,* as Commissioner of Natural Resources of the Commonwealth of Massachusetts.

■ Particular congratulations were being extended to three Alumni as *re-electees,* namely:

To *Thomas C. Desmond, '09,* as a Senator of the State of New York to enter upon his 27th consecutive year of service in that office, thus establishing his record of serving longer than any other member of either branch of the New York State legislature; and upon his re-election for a 10th consecutive year as President of the Phi Beta Kappa Associates . . .

To *Richard Roth, '28,* chosen for a second term as President of the New York Society of Architects . . . to *Wilbur N. Landers, '30,* named for the 11th time as Secretary of the Society of Naval Architects and Marine Engineers.

■ Special honors coming recently to 12 Alumni and members of the Institute Faculty included:

To *Irving W. Wilson, '11,* an honorary doctorate of laws, by the University of Pittsburgh . . . to *Harold F. Dodge, '16,* an honorary Professorship of Statistical Quality Control, by Rutgers University . . . To *Herbert J. Gilkey, '16,* honorary membership in the American Society for Testing Materials . . .

To *Robert E. Wilson, '16* and *Wheeler G. Lovell, '24,* Certificates of Appreciation, by the American Petroleum Institute and presented in Chicago at a meeting of which the presiding officer was *William J. Sweeney, '28* . . .

To *Edward P. Warner, '17,* retiring President of the Council of the International Civil Air Organization, the 1956 Wright Brothers Memorial Trophy, by the National Aeronautic Association . . . To *Andrew I. McKee, '21,* the David W. Taylor Medal, by the Society of Naval Architects and Marine Engineers . . .

To *Edward W. Comings, '34,* the William H. Walker Medal, by the American Institute of Chemical Engineers . . . to *R. Kenneth Bullington, '37,* the Stuart Ballantine Medal for "advancement of space communications by means of beyond the horizon tropospheric wave propagation," by the Franklin Institute . . .

To *Francis O. Schmitt,* Institute Professor, jointly with Professor Karl Meyer of Columbia, a 1956 Albert Lasker Award for their separate biochemical and physical studies of collagen and connective tissue giving new light on rheumatic diseases, by the American Public Health Association . . .

To *Edwin H. Land,* Visiting Institute Professor and Fellow of the School for Advanced Study, the Howard N. Pots Medal for "ingenious development of a practical hand camera and a process to expose and develop the negative and create a good positive simultaneously," by the Franklin Institute.

Visiting Professor of Mathematics

■ Joaquin B. Diaz, noted applied mathematician, has joined the Faculty of the Institute for the current year as visiting professor of mathematics, Julius A. Stratton, '23, Chancellor, recently announced.

Dr. Diaz has been research professor at the University of Maryland's Institute for Fluid Dynamics and Applied Mathematics since 1950. In recent years, he was also research consultant for the Los Alamos Scientific Laboratory and the Naval Ordnance Laboratory at Silver Spring, Md. Through extensive writing he has contributed much to the fields of applied mathematics, boundary value problems, partial differential equations, and elasticity.

Born in Arecibo, Puerto Rico, Dr. Diaz attended Washington and Jefferson College and received his bachelor's degree at the University of Texas in 1940, his Ph.D. at Brown University in 1945. He served on the research staff at Brown from 1943 to 1946, conducting research for the National Advisory Committee for Aeronautics, Pratt and Whitney Aircraft Corporation, and the Watertown Arsenal.

In 1946, Dr. Diaz was appointed assistant professor of mathematics at Carnegie Institute of Technology, and the following year he returned to Brown University as assistant professor. He was named associate research professor of mathematics at the University of Maryland in 1950, and research professor in 1956.

Dr. Diaz is a member of the American Mathematical Society, Phi Beta Kappa, and Sigma Xi. During 1950–1952, he was assistant editor of the *Proceedings of the American Mathematical Society,* and this year has been editor of *Proceedings of the Maryland Conference on Differential Equations.*

Twenty-five Years Ago This Month . . .

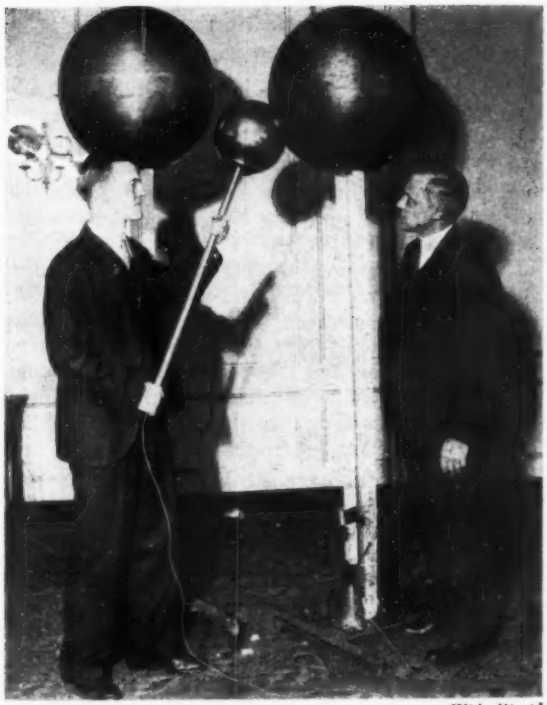
■ With the advent of the new year of 1932, the original group of 55 alumni "Honorary Secretaries" began representing the Institute and its Alumni Association in various centers of the United States, Canada, and Mexico. Chosen for their experience in fields of engineering and business, these honorary secretaries, as the announcement said, were "to provide sources of qualified first-hand information on education in science and engineering, architecture, and business and engineering administration at Technology.

"These academic ambassadors will consult with prospective students from their districts and assist them in determining their qualifications for a technical education. Their work assumes particular importance because of the rapid growth in the number of applicants for admission to the Institute and the necessity for giving precedence to the best students."

Since 1932, further honorary secretaryships have been created so that with the advent of 1957 there is a total of 257, forming the backbone of an Educational Council numbering 678 Alumni. Three of the 55 honorary secretaries appointed in 1932 are still serving actively in that capacity, namely: Terrell Bartlett, '06, at San Antonio, Texas; Frank F. Bell, '10, at Dallas, Texas; and Frederick W. Barker, '12, at Syracuse, N.Y.

. . . Announcement was made in The Review "of a new and marvelously sensitive electrocardiograph for studying the action of the heart," the device being the result of joint research carried on by Vannevar Bush, '16, Professor of Electrical Power Transmission at the Institute, and Professor W. D. Reid, Associate Member in Cardiology of the Evans Memorial Hospital in Boston.

. . . Based upon an experimental 1,500,000-volt model of Professor Robert J. Van de Graaff's new method of producing hitherto unattainable high voltages, "construction of a generating apparatus designed to produce direct current at the amazing potential of 15,000,000 volts is to be undertaken at M.I.T. within the next few months."



Wide World

Robert J. Van de Graaff, Associate Professor of Physics (at left), demonstrating his experimental 1,500,000-volt generator model to the late President Karl T. Compton.

. . . Congratulations were being extended to Lammot du Pont, '01, as President of the Manufacturing Chemists Association; to Charles Camsell, '09, upon receiving the Gold Medal of the British Institution of Mining and Metallurgy; and to Leslie R. Groves, Jr., '17, then Lieutenant of the Corps of Engineers, U.S.A., upon his decoration as Chevalier of the Order of Nicaragua in recognition of his restoration of the waterworks of Manuagua following the March, 1931, earthquake.

GAMES PLAYED

Date 1956	*Event*	*Scores* *Winner*		*Loser*	
Nov. 30	Vars. Rifle	M.I.T.	1410	B. C.	1375
Dec. 1	Vars. Basketball	M.I.T.	74	Trinity	65
Dec. 1	Frosh Basketball	M.I.T.	72	Trinity	71
Dec. 1	Vars. Hockey	Dartmouth	8	M.I.T.	1
Dec. 1	Vars. Wrestling	Wesleyan	15	M.I.T.	12
Dec. 1	Frosh Wrestling	Wesleyan	18	M.I.T.	10
Dec. 5	Vars. Basketball	M.I.T.	73	Clark	64
Dec. 5	JV Basketball *vs.* M.I.T. Frosh	Frosh	68	JV	55
Dec. 5	Frosh Hockey	Scrimmage		No Score	
Dec. 7	Vars. Hockey	N'eastern	15	M.I.T.	4
Dec. 8	Vars. Basketball	Amherst	67	M.I.T.	65
Dec. 8	Vars. Rifle	M.I.T.	1460	Dartm'th	1338
Dec. 8	Vars. Squash	Dartmouth	7	M.I.T.	2
Dec. 8	Vars. Swimming	Bowdoin	44	M.I.T.	42
Dec. 8	Vars. Wrestling	Tufts	17	M.I.T.	10
Dec. 8	Frosh Wrestling	Tufts	14	M.I.T.	14
Dec. 11	JV Basketball	Harvard	70	M.I.T.	30
Dec. 12	Vars. Basketball	Springfl'd	78	M.I.T.	60
Dec. 12	Frosh Basketball	M.I.T.	92	Exeter	69
Dec. 12	Vars. Hockey	Hamilton	5	M.I.T.	1
Dec. 12	Vars. Swimming	M.I.T.	60	R.P.I.	25
Dec. 12	Frosh Swimming	M.I.T.	60	Dean	16
Dec. 14	Vars. Squash	Wesleyan	8	M.I.T.	1
Dec. 15	Vars. Squash	M.I.T.	9	Adelphi	0

Visiting Committee Report on Aeronautical Engineering

■ Eight of the nine members of the Visiting Committee on the Department of Aeronautical Engineering convened on February 19 and 20, 1956, General Joseph T. McNarney unavoidably being absent.* On Sunday evening, February 19, General James H. Doolittle, '24, chairman, was host to members of the Committee and to members of the Department and M.I.T. Administration at the Parker House in Boston. Following dinner, Professor C. Stark Draper, '26, Head of the Department, outlined three important areas which he hoped the Committee would consider at its business meeting the following day: student enrollment, educational curriculum in the broad field of propulsion, and long-range plans for establishing optimum size of the Department.

On Monday, February 20, when the Committee met at the Institute, the aims and objectives of the Department were outlined by Professor Draper, and departmental operations were summarized by Executive Officer Walter McKay, '34, Associate Professor of Aeronautical Engineering. In addition, the research and teaching activities were summarized by members of the Department's Faculty and staff. The members of the Committee gave careful consideration to a broad range of topics on teaching objectives, curriculum (including propulsion studies, guided missiles, and orbital vehicles, computing equipment, communication), and departmental planning (including future enrollment, equipment, and facilities), staff, and student population. The report of the Committee is too detailed and long to be given here. However, the Committee's conclusions and recommendations may be summarized as follows:

1. It is recommended that major efforts be continued to attract students into Aeronautical Engineering, particularly for the Graduate School.

2. It is recommended that the Department expand its education effort in the areas of aeronautical propulsion by increasing the amount of time allotted to this subject, and by revising the course content so that the propulsion field exerts appropriate attraction for students.

3. It is recommended that the Department vigorously extend its planning beyond the immediate future to include provisions for meeting the educational requirements that are anticipated in the future. This planning should include equipment, facilities, and staff under the assumption that present limitations may be removed and that a much larger number of students may be available.

The report of the Visiting Committee was submitted on July 17, was received by the Executive Committee in August, and was considered by the M.I.T. Corporation at its meeting on October 1. The report was received in The Review Office for publication in The Review on October 25, 1956.

* Members of this Committee for 1955–1956 were: James H. Doolittle, '24, chairman, Godfrey L. Cabot, '81, Ray P. Dinsmore, '14, Theodore C. Lonnquest, '25, Paul S. Baker, '29, Athelstan F. Spilhaus, '33, William A. M. Burden, Robert E. Gross, and Joseph T. McNarney.

Russian Roulette

■ Back in the violent days of the Western American frontier, everyone went armed, and a common cause of death was acute lead poisoning in the form of a bullet in some vital part of the body. Today, in peacetime, one is inclined to assume that only criminals and law enforcement officers are at all apt to meet their end by being shot. That this assumption is groundless appears from consideration of the rather startling facts concerning fatal firearm accidents. Such accidents claim some 2,200 lives a year in this country, and are exceeded as a cause of accidental death only by automobile accidents, falls, burns, and drowning.

How can shooting mishaps occur so commonly? Many happen during the hunting season; indeed, nearly two fifths of the fatal firearm accidents happen during October, November, and December. This statistic will surprise no one who has set forth for a quiet tramp in some woodland area in the late fall, only to encounter guns going off on all sides and perhaps an occasional bullet whizzing through the foliage nearby.

Many hunters never touch their guns from one season to the next, and hence may be clumsily unfamiliar with their lethal weapons when they first sally forth into the woods each fall. Besides, to some, each year's hunting expedition is an annual opportunity to shuffle off domestic ties, go off with "the boys," and enjoy liberties that may include alcoholic indulgences.

A most surprising fact, however, is that fatal shooting accidents occur over twice as frequently in homes as in the hunting field. Most of these tragic mishaps come from heedless handling of loaded weapons – often assumed to be unloaded – for the purpose of cleaning or demonstrating them.

Nearly 4 per cent of the 302 fatal accidental shootings of policyholders recently studied by a leading life insurance firm resulted from a practice not wholly accidental in nature – the macabre game called "Russian roulette." As the reader must know, this is a display of bravado whereby the cylinder of a revolver containing one live cartridge is spun by a participant, who then applies the muzzle to his temple and pulls the trigger, on the chance that the hammer will fall on an empty chamber.

How could the pointless human wastage from accidental shooting be stopped? Like all social problems, this one may be tackled either by legal or else by educational means. England has virtually legislated firearms out of existence. Even English police are largely unarmed. But every American citizen has the constitutional right to bear arms, so that the approach in this country has been educational. Sportsmen's associations, and firearm and ammunition manufacturers devote much effort and money to educating people, young and old, on the very special precautions that need to be taken in the handling of firearms. As to the half-accidental, half-suicidal deaths from Russian roulette, it is doubtful whether either compulsion or education could have much effect on the sort of individual inclined to indulge in this kind of sport.

Recently Appointed

■ President James R. Killian, Jr., '26, recently announced the following new appointments:

Robert L. Kyhl, '47, Associate Professor of Electrical Engineering, has had 15 years' experience in microwave and electronics research. With degrees from the University of Chicago and M.I.T., he has been a staff member of M.I.T.'s Electronics, Insulation Research, and Radiation Laboratories; Stanford University's Microwave Laboratory; and General Electric's Research Laboratories.

Patrick D. Wall, Associate Professor in the Department of Biology, is widely known for his research in communications biophysics and neurophysiology. For the past eight years he has taught physiology at Yale, Chicago, and Harvard Medical Schools. A British citizen, Dr. Wall received his medical and surgical degrees at Oxford University.

The following have been appointed assistant professors:

Eugene Bell, in the Department of Biology. Best known for researches in ultrasound, recently applied to studies in embryology, Dr. Bell now teaches at M.I.T. and conducts bioacoustical research at the Massachusetts General Hospital. He holds degrees from New York, Rhode Island, and Brown Universities.

Frank B. Cuff, Jr., '51, in the Department of Metallurgy. He was graduated in metallurgical engineering from Rensselaer Polytechnic Institute and received his doctorate at M.I.T., serving as research assistant and D.I.C. staff member since 1950.

Robert L. Fleischer, in the Department of Metallurgy. A specialist in physical metallurgy, he received his bachelor's, master's, and doctor's degrees at Harvard University, where he was teaching fellow and research assistant from 1954 to 1956.

John Granlund, 10-44, in the Department of Electrical Engineering. An M.I.T. graduate, he has for 10 years conducted research on electrical communications, FM, multipath transmission, and scatter propagation in the Institute's Research Laboratory of Electronics and at Lincoln Laboratory.

Davis H. Howes, in the Department of Economics and Social Science. A graduate of Yale and Harvard, he was assistant professor of psychology at Tulane University, psychologist in the U.S.A.F. Operational Applications Laboratory, and fellow at the Center for Advanced Study in the Behavioral Sciences.

Arthur K. Kerman, '53, in the Department of Physics. In two years at the Institute for Theoretical Physics, Denmark, he has been National Research Council (Canada) fellow and research physicist. He is a graduate of McGill University and of M.I.T.

John A. Swets, in the Department of Economics and Social Science. Applying acoustics to psychology, Dr. Swets was faculty consultant to Electronics Defense Group at the University of Michigan from 1954 to 1956. He received his degrees at the University and also served as instructor in psychology.

Roger W. Wescott, in the Department of Humanities. With degrees from Princeton and Oxford, he taught humanities and sociology at Florida, Boston, and Tufts Universities, and was a Rhodes Scholar.

Record Event

■ That M.I.T. is known for its contributions to science, engineering, and architecture is generally and widely known. That the Institute is also able to make noteworthy contributions in arts and humanities has become equally true during the past decade, even if not yet so widely recognized. Among the students – and Faculty – at M.I.T., music has long played a stimulating and significant role. Now M.I.T. has gone "on record" with three disks, called "Music at M.I.T.," which have been released recently by Unicorn Records, an enterprising young Boston concern.

In order that an unbiased account of "Music at M.I.T." may be brought to readers of The Review, we report, without comment, what the *Christian Science Monitor* had to say about the Unicorn recordings. Says the *Monitor* in its issue of September 25, 1956:

The term "engineering," long synonymous with M.I.T., must now include the idea of record engineering. For although the technical work was done by an outsider, the youthful master o. the science and art of tape recording. Peter Bartók (son of the great composer), it is the school which has supplied the ideal performing locations. The first hurrah, therefore, is shared by Mr. Bartók with the Kresge Auditorium and the M.I.T. Chapel in Cambridge.

On the humanities faculty of the Institute for several years has been the Swiss pianist-composer-philosopher Ernst Levy, a musician of towering stature. On UNLP 1033 he plays Beethoven's Sonatas Opus 109 and Opus 110 in masterly fashion, both technically and interpretively. One may disagree with some of Mr. Levy's concepts, which are often highly individualistic and untraditional; but one is likely to be enthralled by his perceptiveness, the deep thought and firm conviction that shine through all his music-making. The readings, accomplished at the Kresge Auditorium with infinite care and patience, are splendidly recorded.

In the same responsive hall, Roger Voisin and his Brass Ensemble from the Boston Symphony Orchestra have made a companion disk to their earlier one, "The Golden Age of Brass." It is titled "The Modern Age of Brass" (UNLP 1031) and contains four outstanding works of so-called "brass chamber music."

There is the demanding and substantial "Music for Brass Instruments" by the German-born American composer Ingolf Dahl, Paul Hindemith's virile "Morgenmusik" (an early landmark in the literature – 1932), Nicolai Berezowsky's brilliant and entertaining "Brass Suite," and Robert Sanders' solid and attractive "Quintet in B-flat." The playing is unsurpassable in security and "bite," and the sound is top-notch as expected. Good notes by Stuart Grover.

Perhaps the most astounding sonic achievement of the set is the recording of four Handel Organ Concerti in the "windowless brick cylinder" of the M.I.T. Chapel (UNLP 1032). Only 50 feet in diameter, the much-argued-over building has turned out to be a flawless recording studio. The young organist of St. Paul's Cathedral in Boston, Lawrence Moe, makes the superb little Holtkamp organ speak with the finest color combinations. . . .

The "Unicorn Concert Orchestra" is conducted with an assured sense of form and balance by M.I.T.'s music director, Professor Klaus Liepmann, to whose vis'on and devotion much of the artistic renaissance of the Institute must be credited. One has no hesitation in placing the disk at the top of the available recordings of Handel's invigorating organ works.

Council Meeting 320

■ As President of the Alumni Association for the current year, Theodore T. Miller, '22, opened the 320th dinner meeting at the Faculty Club on the evening of November 26. Before an audience of 142 members and guests, Mr. Miller's first official duty was to present a gavel to Dwight C. Arnold, '27, commemorating his year of service as the 62d President of the Alumni Association for 1955–1956.

John W. Kilduff, '18, who had been appointed chairman of a special committee responsible for obtaining 100 per cent participation in the Alumni Fund by members of the Council, reported that 41 per cent of this group had already contributed as of November 26. He also expressed the hope that 100 per cent participation would be achieved by the next meeting, so his committee could be disbanded. As chairman of the Alumni Fund Board, Avery H. Stanton, '25, reported that 3,697 Alumni had contributed a total of $98,480 to the Fund as of November 26. This represents an increase of 570 contributors and $20,000 over corresponding figures for the same date a year ago.

As Secretary of the Association, Donald P. Severance, '38, reported that, since the October 29 Council meeting, 18 visits to local clubs by 17 different members of the Institute and Association staffs had been made to points as far as Seattle, San Francisco, Houston, and Charleston. He also reported plans for the Midwinter Meeting on January 30, and the Regional Meetings in Tulsa on February 2 and in Chicago on February 16.

D. Reid Weedon, Jr., '41, chairman, and David W. Skinner, '27, deputy chairman, for the 1957 Alumni Day, have nominated the following subcommittee chairmen: *Registration* – Wolcott A. Hokanson (Staff); *Luncheon* – William L. Taggart, Jr., '27; *Banquet and Entertainment* – Dr. Egon E. Kattwinkel, '23; *Publicity* – John T. Fitch, '52; and *Reception* – William Morrison (Faculty Club).

Professor H. Guyford Stever, who this summer returned to M.I.T. as Associate Dean of the School of Engineering, after 18 months as chief scientist of the U.S. Air Force, was introduced and spoke on "The New Military Aeronautics." His talk outlined the present state of aeronautical engineering with special reference to guided missiles, pilotless bombers, and ballistic missiles. The various aeronautical sciences that have grown rapidly to make possible the accelerated proliferation in aeronautics were also mentioned. Professor Stever expanded his central theme by discussing separately the four traditional fields of aeronautics: propulsion; aerodynamics; structures; guidance and control.

Final speaker of the evening was Julius A. Stratton, '23, Chancellor, who spoke on "The Evolving Scene at M.I.T." Dr. Stratton undertook the extremely difficult assignment of describing some of the important yet intangible changes that have been taking place at M.I.T. – not the obvious changes of bigness or complexity, but the more basic changes in attitudes, emphasis, and teaching methods.

Of great interest was Chancellor Stratton's review of the distribution of the M.I.T. student body by professional courses. For all of his comparisons he chose the years of 1892–1893, 1908–1909, 1922–1923, and 1956–1957 when the Institute Presidents were respectively: Francis A. Walker, Arthur A. Noyes, '86, Samuel W. Stratton, and James R. Killian, Jr., '26. The interesting fact was brought out that the percentage of Electrical Engineering students is *not* greater than in 1892, for example. But there has been a substantial percentage increase in the enrollment in the fields requiring greater scientific background in mathematics and physics. Similar changes take place today in course distribution as classes proceed from the freshman year through the senior year into graduate work.

Much has been said of the increases in enrollment, academic budgets, and tuition over the years. However, Dr. Stratton reviewed these data from the standpoint of ratios of students to staff and average academic expenses per student. There are now approximately five and a half students per staff member – a far better ratio than at any time in the Institute's history. With the average academic expense of $2,800 per student, tuition still pays less than half the Institute's academic expenses.

Dr. Stratton showed the phenomenal changes in curricula in the past 65 years. In 1892 neither physics nor calculus was required in the freshman year, but there was far greater emphasis on foreign languages. Much more time was devoted to language, literature, economics, and history in 1892 than in 1956. There was also strong emphasis on drawing and shop and applications half a century ago. Using the Electrical Engineering course curriculum as an example, professional work was introduced into the curriculum in the senior year – far later than now.

This is in deep contrast to the present time when strong courses in calculus and physics are given the first term of the freshman year and when the steady increase in numbers of sections of intermediate and advanced work in mathematics and physics is demanded by students of other courses, such as Electrical Engineering. Professional work is given earlier; the increased emphasis on humanities comes not from an increase in time devoted to the subjects but from improvement in caliber, sequence, and relevance of the present humanities program.

And what of these problems in the future? Engineering education is faced with the necessity of adjusting itself to a rapidly changing world for which we need clear precepts for long-range planning. The specific issues involved are too many to be listed, and many have yet to be formulated clearly. Among these issues are the following: How should M.I.T. respond to the nation's need for professional man power in engineering? Can undergraduate education in engineering serve the role of professional education as well as general education? Where are the proper boundaries in engineering education between applied science and contemporary practice? How can engineering education retain its role as the basis of training for future leadership in industry? How can M.I.T. strengthen the creative resourcefulness and imagination which are indispensable to the vigorous industrial activity of the nation, but so often suppressed in the academic environment? Should M.I.T. undertake specialized education for selected people with exclusive specialization in the applied sciences?

■ A 16-millimeter sound motion picture in color, depicting extracurricular life of Technology students, has recently been completed and is available, on loan, to Alumni Clubs, Educational Counselor groups, and others having need for such material. Produced by Oscar H. Horovitz, '22, with the assistance of the Institute Committee, the film was originally made at the suggestion of B. Alden Thresher, '20, Director of Admissions.

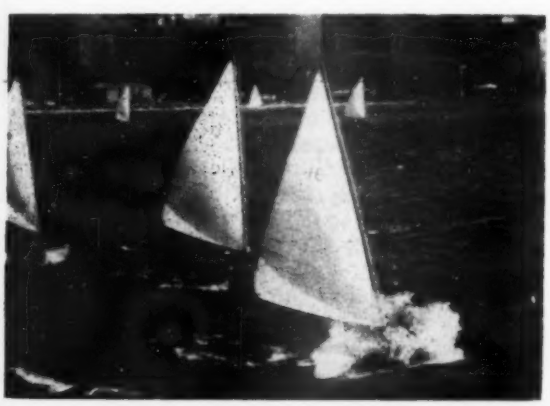
To emphasize the unusual social and extracurricular activities which are available to students entering the Institute, the film entitled "The Social Beaver" deals almost exclusively with the social, recreational, and extracurricular activities to be found at M.I.T. Alumni who still think of the Institute as a haven for "brown baggers" will find many athletic, hobby, student government, and social activities portrayed in this half-hour film. For example, crew and dinghy sailing now play a major part in M.I.T. aquatic sports, as does swimming, also. Students gain a good knowledge of publication procedures through work on *The Tech, Tech Engineering News, Voo Doo,* and *Technique.*

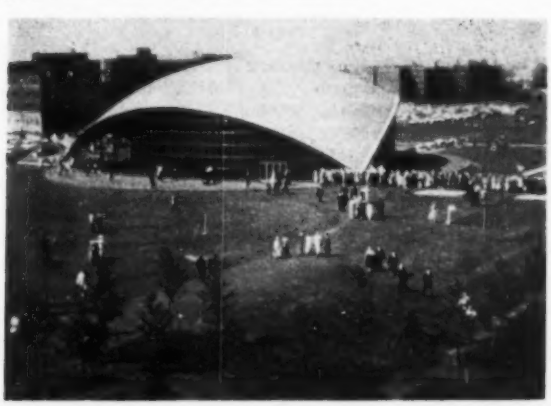
Musical events are now a major attraction for many students after classes end in the afternoon. The Railroad Club, Hobby Shop, Radio Club, broadcasting activities, Flying Club, and Rocket Club are now popular activities which, for the most part, were unknown to prewar generations of Technology Alumni.

A portion of the film familiar to almost all Technology Alumni is that part dealing with Field Day, in which a variety of track and field events are portrayed as photographed on a dark rainy Saturday in the fall of 1955.

The social side of student affairs is illustrated not only by scenes of dances, teas, and similar events, but also by depicting typical living in dormitories, fraternity houses, or in the women's dormitory. A section of the film is — appropriately enough under present conditions — devoted to activities of Technology's hundred, or so, women students, and to its colony of married students.

Although little attention is apportioned to classroom activities in this film, the intellectual demands of four years of study at M.I.T. are inferred by the last group of scenes, which show graduation exercises and the President's luncheon held immediately thereafter in the Great Court. Illustrations on this page are from "The Social Beaver."





Calendar of Technology Sports

Date 1957	Time P.M.	Event	M.I.T. Playing	At
Jan. 8	8:30	Varsity Basketball	Harvard	Harvard
Jan. 9	7:00	Freshman Swimming	Tufts	M.I.T.
Jan. 9	8:30	Varsity Swimming	Tufts	M.I.T.
Jan. 10	4:00	Freshman Basketball	Gov. Dummer	Gov. Dummer
Jan. 10	6:45	JV Basketball	Burdette Jr. Col.	M.I.T.
Jan. 11	4:00	Varsity Hockey	Williams	M.I.T.
Jan. 11		Varsity Rifle	Wentworth	M.I.T.
Jan. 12	2:00	Varsity Fencing	Trinity	M.I.T.
Jan. 12	2:00	Varsity Squash	Williams	M.I.T.
Jan. 12	2:00	Freshman Wrestling	Roxbury Latin	M.I.T.
Jan. 12	3:00	Freshman Hockey	Middlesex	Middlesex
Jan. 12	3:00	Freshman Squash	Brooks	M.I.T.
Jan. 12	3:00	Freshman Swimming	Exeter	Exeter
Jan. 12	7:00	Varsity Hockey	Bowdoin	Bowdoin
Jan. 15	4:00	Freshman Squash	Harvard	Harvard
Jan. 15	4:30	Freshman Basketball	Harvard	Harvard
Jan. 16	6:15	JV Basketball	Wentworth	M.I.T.
Jan. 16	6:30	Freshman Hockey	Boston English	M.I.T.
Jan. 16	7:00	Varsity Hockey	Amherst	Amherst
Jan. 16	7:30	Varsity Fencing	U. of Conn.	M.I.T.
Jan. 16	8:15	Varsity Basketball	Bates	M.I.T.
Jan. 19		Indoor Track	K of C Games	Boston Garden
Jan. 26		Varsity Rifle	Coast Guard	New London
Jan. 26		Skiing	Brown U.	Eastern Slopes, N.H.
Jan. 28		Varsity Rifle	Navy	Annapolis
Jan. 30		Varsity Rifle	Army	West Point
Jan. 31		Varsity Rifle	St. Johns	St. Johns
Feb. 1		Varsity Rifle	U. S. Merchant Marine	King's Point
Feb. 2		Indoor Track	Boston A.A.	Boston Garden
Feb. 3		Skiing	Asa Osborne Trophy	Manchester, Vt.
Feb. 5	4:00	Varsity Squash	Harvard	M.I.T.
Feb. 6	6:30	JV Basketball	Wesleyan	Wesleyan
Feb. 6	7:30	Varsity Fencing	Bradford Durfee	M.I.T.
Feb. 6	8:15	Varsity Basketball	Wesleyan	Wesleyan
Feb. 9	2:00	Varsity Fencing	C.C.N.Y.	C.C.N.Y.
Feb. 9	2:00	Varsity Hockey	U. of Mass.	U. of Mass.
Feb. 9	2:00	Varsity Swimming	Coast Guard	M.I.T.
Feb. 9	3:00	Varsity Wrestling	Boston U.	M.I.T.
Feb. 9	8:30	Varsity Basketball	W.P.I.	Worcester
Feb. 9		Indoor Track	Millrose Games	New York
Feb. 10		Skiing	N.E. College Trophy	Manchester, Vt.
Feb. 12	7:15	Varsity Swimming	U. of Mass.	M.I.T.
Feb. 13	3:00	JV Squash	Middlesex	M.I.T.
Feb. 13	3:00	Freshman Swimming	St. George	St. George
Feb. 13	4:00	Freshman Hockey	Lawrence Acad.	M.I.T.
Feb. 13	4:00	Freshman Wrestling	U. of Mass.	U. of Mass.
Feb. 13	4:00	Varsity Wrestling	U. of Mass.	U. of Mass.
Feb. 13	6:15	Freshman Basketball	Boston U.	M.I.T.
Feb. 13	7:30	Varsity Fencing	Harvard	M.I.T.
Feb. 13	8:15	Varsity Basketball	Boston U.	M.I.T.
Feb. 15		Varsity Rifle	Northeastern	North-eastern
Feb. 15	4:00	Varsity Squash	Army	M.I.T.
Feb. 15	6:15	JV Basketball	M.I.T. Freshmen	M.I.T.
Feb. 15	8:15	Varsity Basketball	Bowdoin	M.I.T.

Curtis Studios

William L. Stewart, Jr., '23

Life Member of the M.I.T. Corporation

William L. Stewart, Jr., '23, of Pasadena, Calif., has been elected to life membership on the Corporation of the Institute, James R. Killian, Jr., '26, President, recently announced. He has been an alumni term member since 1952.

Mr. Stewart is executive vice-president of the Union Oil Company of California and has been with the company since 1923 when he was graduated from M.I.T. He is a director of a number of oil and gas corporations. During World War II he was chairman of the Refining Committee, District V Petroleum Administration for War, and of the Petroleum Industry War Council. He is a trustee of California Institute of Technology and Stanford Research Institute.

Visiting Committee Report on Mathematics

■ Although it held no formal meeting for the academic year 1955–1956, the Visiting Committee on the Department of Mathematics* considered the needs of the Department by means of correspondence and written reports. Current problems of enlarged staff to meet enlarged enrollment, additional space for a greater number of students and staff, and improved facilities for the library of mathematical works are similar to those previously discussed by other Visiting Committees. Although important steps have been taken in each of these categories, the same

(*Concluded on page 160*)

*Members of this Committee for 1955-1956 were: Everett S. Coldwell, '15, chairman, Francis J. Chesterman, '05, Hugh S. Ferguson, '23, John Stack, '28, Brockway McMillan, '36, Albert C. Schaeffer, '36, Richard Brauer, Gustav A. Hedlund, and William R. Sears.

Education of the Uncommon Man

In tomorrow's technological world the best utilization of the best available brain power will be essential. To achieve this, America still has something to learn

by EDWIN S. BURDELL

My chapter and verse reference for the expression "uncommon man" stems not from the work of an educator but rather from a talk made last April by the industrialist, Crawford H. Greenewalt, '22. His words are worth repeating:

"Behind every advance of the human race is a germ of creation growing in the mind of some lone individual, an individual whose dreams waken him in the night while others lie asleep.

"We need those dreams, for today's dreams represent tomorrow's realities. Yet, in the very nature of our mass effort, there lies this grave danger – not that the individual may circumvent the public will, but that he will himself be conformed and shaped to the general pattern, with the loss of his unique, original contributions . . . The great problem, the great question, is to develop within the framework of the group the creative genius of the individual . . .

"I know of no problem so pressing, of no issue so vital. For unless we can guarantee the encouragement and fruitfulness of the uncommon man, the future will lose for all men its virtue, its brightness, and its promise."

Modern society is making tremendous demands on its natural resources and even greater demands on its human components. It is absorbing the mineral wealth in prodigious quantities; but when exhaustion of known supplies seems imminent, substitutes are found and rare equivalents of organic products are synthesized from plentiful inorganic sources through the ingenious ideas and efforts of human beings. But whatever demands society has made on its human resources, it must in the future make greater ones still. As Dr. John R. Weir pointed out in the recent California Institute of Technology conference on civilization in the Twenty-first Century, "the critical limiting factor on the world's resources is not materials, energy or food, but brain power." In tomorrow's technological world the best utilization of the best available brain power will be essential. To achieve this, America has something to learn.

Our American democracy has fought shy of elite groups, whether by birth, wealth, or brains. We have promoted an egalitarianism which runs the risk of defeating our efforts to meet our more pressing needs. Our teachers are paid less than our factory workers, and their station in life financially is rated not much above that of the common soldier and salesman. Occasionally waves of anti-intellectualism threaten to stifle the exploration of the unknown, whether physical or social. The vulgar expression sometimes applied to an intellectual to the effect that "he is too smart for his breeches" has an implication of fear as well as disdain. The recent fad of applying the term "egg head" to anyone who displays unusual intellectual ability seems to imply distrust of the intellectual as a sort of misfit in a mass of conformity. Be this as it may, the development of the potential brain power of intellectually superior men and women is our greatest need. Unless we are willing to run the risk of educating a few intellectual misfits beyond their capacity of assimilation, we will never succeed in increasing the supply of indispensable men and women, the uncommon men and women.

Education for the masses is a Twentieth-Century phenomenon. During the past 50 years there has been a steady increase in the proportion of young people going to school and college. High school enrollment for the 14–17 age group rose from 11 per cent in 1900 to 80 per cent in 1954. College enrollment for the 18–21 age group rose from 4 per cent to 30 per cent. While the size of these two age groups increased by less than half, high school and college enrollments rose nearly tenfold. We now are making a college education available to 2,600,000 persons a year, and by 1960, assuming a 40 per cent college attendance of the college age group, it is predicted that 3,600,000 will be attending college. Even so, we have reason to believe that less than half of those intellectually qualified are headed for college and only half of these are able to finance the costs of a residence college experience.

Indication of our failure to use our greatest national resource is to be found in a recent report of the Conservation of Human Resources Project set up five years ago at Columbia University when Dwight D. Eisenhower was president of the University, which maintains that among those individuals with the most aptitude for learning (those who score in intelligence tests in the upper 6 per cent of the population) less than half are graduated from college. The report goes on to point out that any personnel policy which differentiates sharply between college-trained and non-college-trained is dangerous. The college-trained group includes many individuals of quite average and perhaps inferior ability, while the non-college-trained group includes many very able persons. To cite contemporary examples, both foreign and domestic – in the highly technical fields of building construction, city planning and architecture – it is in-

teresting to note that Nervi, the brilliant Italian building designer, Gropius, the distinguished German city planner, and Frank Lloyd Wright, the famous American architect, had little formal schooling.

However, the crux of the matter is not providing the facilities and means for increased numbers of youth to go to college as an end in itself. The crux of the problem is how to discover those most talented youths and to motivate them to seek the education and training needed to cope with the increasingly complex situation. If society is to survive, it must be as much concerned with the uncommon man of brains and integrity as it is with the enlightenment of the masses of mankind.

Identifying and Motivating the Uncommon Student

The anxiety about the "tidal wave" of students which will flood our schools and colleges in the next years might well be extended to an anxiety about how to develop creative capacity in the most talented of these students. Real as is the shortage of buildings, teachers, and endowment to cope with this flood, the central problem is how to discover the talented youth in elementary and high schools in order to make sure that he is encouraged to take those subjects which will develop his interest in the pursuit of science, whether in the natural sciences or the social sciences.

In order to identify talented young people and to discover the directions in which their talents tend, it is necessary to expose as many of them as possible to as many types of activity as possible, so that out of their relative rates of growth in each activity we may determine the talents most useful to society and rewarding to the individual. This process should be initiated when the pupil is of secondary school age, at the most; and perhaps it can be achieved through a comprehensive approach that will utilize not only an improved educational program in the high schools but also the manifold educational influences that exist in the community.

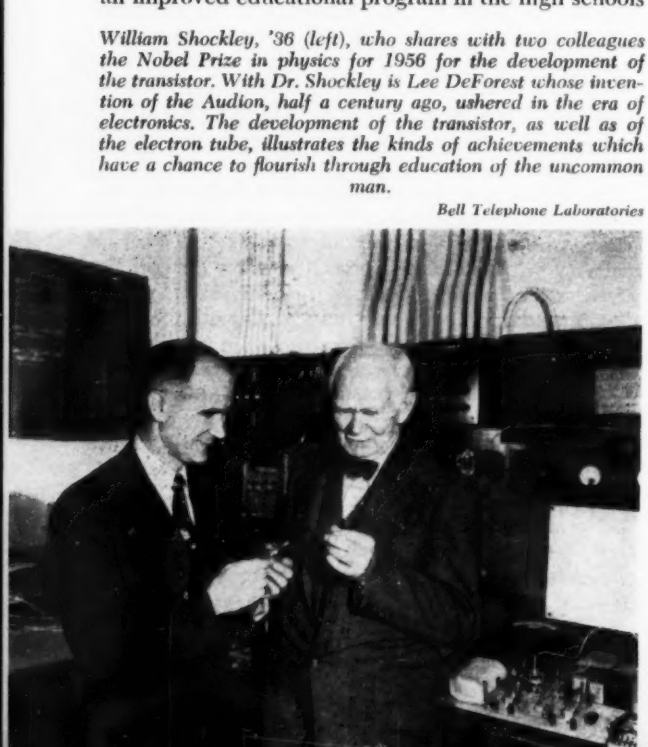
We need new patterns of secondary school training related to newly valued capacities and professions such as the peacemaker, co-ordinator, politician, researcher, analyst, and designer. At the same time, the resources of the community can be brought to bear on the widening awareness of the young. Industrial leaders, scientists, designers, and professional men who have a capacity for colorful direct speech would be valuable as occasional speakers to high school students who are at the stage of considering college and career. Leaders of boys and girls in organized groups in the community, such as Scouts, Little League baseball clubs and Sunday schools, could make much more of vocational discussions and excursions to hospitals, courts, studios, industries, and especially to laboratories. This may seem trite and trifling and a far cry from the serious business of matriculation into a professional school, but the teen-ager after all is sorting out a confusing jumble of stimuli, and out of that confusion, choices and rejections are being made consciously or unconsciously. "As the twig is bent, so is the tree inclined," is an old adage worth bearing in mind here. If we would increase the nation's utilization of its potential brain power, we must start early, use all the resources at our command, and use them with increasing imagination and vigor.

The teacher's role in the discovery and motivation of pupils with unusual talent cannot be overestimated. Yet in certain important areas in secondary education the scarcity of good teachers imperils any program that might be designed to encourage superior talent. The fields of mathematics and physics provide a frightening example. A representative sample of elementary and high school students reported to the Educational Testing Service in a recent survey that mathematics was their most disliked subject. Much more startling was the fact that 150 of 211 prospective elementary school teachers stated they had a long-standing hatred of mathematics. The survey observed that "Future teachers pass through the elementary schools learning to detest mathematics. They drop it in high school as early as possible. They avoid it in teachers college because it is not required. They return to the elementary school to teach a new generation to detest it." Good teaching, successful pupil performance, and a high motivation usually are found together, and it is impossible to say which are the causes and which are the results. The uncommon pupil will flourish in any situation where these factors are present but will not be likely to discover his talents in an atmosphere of avoidance and distaste for mathematics, the basic language of science. We must develop a situation at the elementary and high school level in which there is an eager lot of youngsters crying for more mathematics, instead of the vast majority avoiding mathematics.

The uncommon student needs to be encouraged and rewarded once he or she is identified. Such youth should be watched carefully by teachers and community leaders, every inducement should be offered by way of scholarship, and preferential treatment as to independent studies at the youth's own pace should be afforded. That this responsibility for de-

William Shockley, '36 (left), who shares with two colleagues the Nobel Prize in physics for 1956 for the development of the transistor. With Dr. Shockley is Lee DeForest whose invention of the Audion, half a century ago, ushered in the era of electronics. The development of the transistor, as well as of the electron tube, illustrates the kinds of achievements which have a chance to flourish through education of the uncommon man.

Bell Telephone Laboratories



tection and identification of the uncommon student would be difficult for our overloaded elementary and high school teachers is obvious, but in looking for some magic to solve our problem, we may be overlooking the "geiger counter" potentialities of those teachers.

The New York City Board of Education is experimenting in this direction by developing an integrated curriculum up through the twelfth grade, which should lead to the detection and encouragement of gifted science students. The students are afforded first-hand experiences in science, including laboratory and demonstration experiences, rather than verbalizations. In order to make the most of these innovations at the elementary level, the Advisory Committee on Science Manpower, of which the writer is a member, recommended to the Board that (1) in all of the academic high school courses, students be required to take at least one year of a science, (2) guidance counselors and advisers make every effort to attract and guide more students to take advanced sciences and to dispel unfounded fears of these subjects, and (3) provisions be made for science clubs and related activities at all levels of the school program in order to develop lasting interests in science.

The American Association for the Advancement of Science pointed out that only 249 men and women who had prepared to teach high school physics were graduated from colleges in the United States in the spring of 1956. And only half of these few graduates will actually be teaching high school classes next fall. The other half will have drifted into other occupations because of more attractive employment opportunities. One hundred twenty-five new physics teachers are clearly far too few to replace those lost through death, retirement, and resignation from the nation's 25,000 high schools and to teach the additional classes called for by an enrollment that is well above the six million of three or four years ago and that is expected to increase to 11 or 12 million by 1965. In recent years the number of college graduates prepared to teach high school physics has dropped 74 per cent.

The Advisory Committee on Science Manpower learned that in June, 1956, the five New York municipal colleges graduated 465 teachers in all fields of secondary education, of whom 52 are equipped to teach science and 28 mathematics, and it is estimated that of those, only 35 will go into the city system to teach science and 20 to teach mathematics.

It would seem then, that a threefold program needs to be instituted at the secondary school level in order to establish the foundation for the education of the uncommon man in the future. That program must include improved patterns of high school training, increased utilization of community facilities, and a radically increased number of teachers well qualified in the scientific field in which unusually talented workers will be increasingly in demand.

College Experience for the Uncommon Man

If the uncommon man is to prosper most from his college experience, he must be given a professional education that is "first-rate." What characterizes such

Bill Sears from Black Star

an education? According to the 1955 Report of the American Society for Engineering Education's Committee on Evaluation of Engineering Education, the objectives of engineering education are twofold, one technical, the other social:

> The first objective, the technical goal of engineering education, is preparation for the performance (or full knowledge) of the functions of analysis and creative design . . . the second objective, the broad social goal of engineering education, includes the development of leadership, the inculcation of a deep sense of professional ethics, and the general education of the individual. . . .

Although these objectives refer specifically to engineering education, they apply with equal significance to all professional education.

Few people would quarrel with these as desirable objectives. The arguments begin when the subject of "how the objective may be implemented most effectively" is raised. And methods should differ, depending on the character of the institution, its faculty, and students. The kinds of curricula and courses designed for the average student, for example, may put the uncommon student in a mental strait jacket, may restrict the full play of his intellectual and creative powers. What is the answer for the outstanding student? If he is to develop the capacity for creative originality, we cannot regiment him. Yet we cannot permit his undisciplined self-indulgence in education. The apparent dichotomy is not insoluble; the conflict can be resolved by, and only by, raising discipline above regimentation.

Perhaps the most important stimulus to the creative mind is the freedom to explore. This is borne out

(*Continued on page 168*)

Scientific and Engineering Man Power

In an age of supersonic flight, we can no longer rely on horse-drawn educational systems. A second-best educational system may be more perilous than a second-best Air Force. These, and other conclusions, are condensed from an address

by JAMES R. KILLIAN, JR.

THE United States has temporized in the face of its acute shortage of scientists and engineers," James R. Killian, Jr., '26, President, declared in New York City on November 14. The occasion was the annual dinner of the M.I.T. Club of New York at which Alfred P. Sloan, Jr., '95, honorary chairman of General Motors Corporation, received the Club's Silver Stein Award for "inspiring leadership and devoted labors" on behalf of M.I.T. The presentation was made by Crawford H. Greenewalt, '22, President of E. I. du Pont de Nemours and Company.

"There has been a Niagara of talk about how short the shortage is and why. There has been precious little remedial action. Many have been taking the patient's temperature; few have mobilized means to buy some medicine," said Dr. Killian.

"Obviously, one way to ease the shortage of scientists and engineers is to use the ones we have with maximum effectiveness. The heaviest pressure on our scientific man power at this time comes mainly from our massive and necessary defense program; over half of all scientists and engineers engaged in research and development are working directly or indirectly for the Federal Government. Obviously, this Federal program must have first attention as we seek more efficient utilization of scientific man power. This brings us immediately up against the hard fact that we have not yet reached the point in the clarification, much less the integration, of the roles and missions of the military services, where we can handle our evolving weapons systems technology with high efficiency. In our military establishment we do not have the organizational integration or the decision-making machinery to manage weapons development, and procurement, without some unprofitable duplication of effort arising out of inter-service rivalry and competition. As a result of this lack of organizational coherence and integration of roles and missions we needlessly increase defense costs, we lengthen our lead time, and we waste technological man power," Dr. Killian remarked.

In speaking of scientific and engineering man power, Dr. Killian reviewed related educational needs:

"One of the most urgent needs in our defense organization is for men, whether they be in uniform or civilian dress, who understand the integration of systems and the organizational implications inherent in our rapidly advancing weapons technology. Our universities, and particularly our engineering and military schools, have a responsibility to train this new breed of administrator and engineer, not only for government but for industry, for industry, too, has increasing need for this special kind of technological thinking and management."

Dr. Killian emphasized the need for an adequate large-scale national scholarship program and the need for substantial increases in faculty salaries to attract and hold first-rate teachers. He said that our schools generally must have greater support to cope responsibly with their swollen enrollments, and called the recommendation by the Committee for the White House Conference on Education to double our national expenditures for education a basically essential move.

Dr. Killian stressed the need for change in American attitudes toward higher education:

"We have as yet no adequate large-scale national scholarship program to help and attract into college some 200,000 gifted high school graduates who now cannot afford or are not motivated to go to college. Despite the growing aid of industry and the establishment of fine programs such as the National Merit and Alfred P. Sloan Scholarships, only about a quarter of the scholarship assistance needed is now available. While we need more financial aid to encourage needy but gifted students specifically to study mathematics, science or engineering, our top priority need is to help all of our top talent, regardless of the careers they choose. It has not yet been conclusively shown that increasing our pool of scientists and engineers will curtail the supply of needed talent in any other profession. It is more likely to be true, as the White House Conference Committee on Education observed, that 'if no talent is wasted in our land, no skills will be lacking.'

"In an age of supersonic flight," he said, "we cannot rely on a horse-drawn educational system. A second-best educational system," he added, "may be more perilous than a second-best Air Force.

"Despite the great intellectual edifices science has built in our Western culture," he said, "it has been opprobriously tagged as 'vocational' and 'antihumanistic,' and in the minds of many academicians, assigned an inferior place in the hierarchy of intellectual activities.

"The near collapse of science teaching in the high schools suggests that too many teachers, administra-

tors, school board members, and parents have been influenced by this latent hostility to science. The question is now appropriately asked: 'Is it possible that liberal arts education, which dominates the education of most of our teachers, has failed in part to make science a meaningful part of its education?' Certainly there is evidence that many of the nonscience majors in liberal arts colleges, by avoiding science, end with a more limited and specialized education than the science majors," he said.

Dr. Killian also cited the need for renewed cooperation between secondary school and college teachers of science and mathematics, and urged "that our American schools of engineering and institutes of technology seek as a group to command more understanding and support throughout the nation. They have not yet, for example, achieved the recognition and status of our medical schools."

To ease the heavy demand for engineers, Dr. Killian called for an "increase in the number of technical institutes and other post high school institutions for training engineering aids, technicians, and other sub-professional personnel. We need, in fact, a greater spectrum of institutions of different and recognized levels of intellectual performance and specialization. This does not mean that some of these should be of low quality and some of high quality. It means rather that we need high-quality institutions at a variety of different points in the educational spectrum to meet the varied scope of skills and intellectual attainment required by our industrial society.

"Next, we need to increase the number of engineering schools staffed and equipped to give graduate degrees on engineering. To accomplish this will entail enlarged faculties, lighter teaching loads, more opportunities for faculty and students to engage in research.

"Until now our chief reliance in the United States has been on an undergraduate preparation for professional engineering careers – a system which has not universally risen above the training of technicians. While there will long continue to be an appropriate and essential place for the really professional four-year undergraduate engineering program, it must be supplemented by the expanded provision for graduate study of which I speak. Many industrial companies have been ahead of the colleges in recognizing the need for engineers of such higher attainments. As a consequence, they have evolved training programs of their own to carry their engineers beyond the levels these young men achieved in their four-year undergraduate engineering education. To the extent that industry has had to do this because of the inadequacy of the preparation of their engineers in the colleges, they have had to make up for the defaults of education. If we had the graduate school capacity to handle them, it would be more appropriate and advantageous in the long run for these men to receive their advanced training in college rather than in industry. The engineer, no less than the scientist, can benefit from advanced professional study in an atmosphere of uncommitted research. Our technological advance in the United States will be more certain if the top graduates of our four-year engineering schools proceeded on to graduate study. By their greater insight into engineering science and by increasing their mastery of the more profound and theoretical aspects of engineering, these engineers will be better equipped to advance the frontiers of technology."

F. S. Lincoln, '22

The Biltmore Hotel was the scene, on November 14, of the Silver Stein Annual Meeting of the M.I.T. Club of New York at which President Killian's "Scientific and Engineering Man Power" address was delivered. Head table guests on this important occasion included: Bernard H. Nelson, '35 (not visible in this view); Mrs. H. E. Lobdell; Theodore T. Miller, '22, President of the Alumni Association; Mrs. Thomas C. Desmond; Crawford H. Greenewalt, '22; Mrs. Mervin J. Kelly; President James R. Killian, Jr., '26; C. George Dandrow, '22; Alfred P. Sloan, Jr., '95, to whom the Silver Stein was presented; Mrs. Theodore T. Miller; Mervin J. Kelly; Mrs. Bernard H. Nelson; Thomas C. Desmond, '09; Mrs. C. George Dandrow; and H. E. Lobdell, '17, Executive Vice-president of the M.I.T. Alumni Association, in left to right order.

Encomium

In awarding the Silver Stein of the M.I.T. Club of New York to Alfred P. Sloan, Jr., '95, his eminent service as public-spirited citizen, philanthropist, humanitarian, Alumnus are eulogized

by CRAWFORD H. GREENEWALT

THERE is little need for us to review the accomplishments of the man we are honoring tonight – they are too well known to require repetition. We all know the story of his coming to General Motors when that company acquired the assets of the Hyatt Roller Bearing Company – the most distinguished and valuable asset of which turned out to be Alfred P. Sloan, Jr., '95, himself. We all know of his career in the General Motors Corporation and of his notable contributions to science, to finance, and to what has come to be called the art of management. Even a most perfunctory appraisal of Alfred Sloan as industrialist and organizing genius would, of course, call for far more time than I have been allotted, and even if I had complete carte blanche, I am sure I could not do it justice.

It is, furthermore, not his role as a business leader, but his role of public-spirited citizen, philanthropist, and humanitarian that concerns us tonight. In these fields, Alfred Sloan has shown the same wise and creative thinking which has characterized his career in industry. This need surprise no one, for uncommon endowments never circumscribe men within a particular field of endeavor. Mr. Sloan's grasp of human values is quite as notable as his understanding of the industrial scene. His benefactions have been numerous and generous, beyond the willingness and capacity of most men, but I am quite sure that the contributions of his mind, his understanding, and his heart far outweigh those of his bank account.

This is an M.I.T. meeting, and so it is proper for me to speak particularly of what he has done for the Institute. The Automotive Engine Laboratory, the Metals Processing Laboratory, the Sloan Building for the School of Industrial Management, and to a large extent, the Karl Taylor Compton Laboratories, stand as evidence of his financial generosity. But beyond this, and of basically greater importance, are his contributions in time, effort, and imaginative thought to the affairs of the Institute. He has been chairman of the Corporation's Development Committee, chairman of the Advisory Council for the School of Industrial Management, and a member of the very important Finance Committee, responsible for the Institute's investments. Whenever an M.I.T. problem comes up for discussion, Alfred Sloan is sure to produce ideas that are both new and productive. I know of no man to whom M.I.T. owes a greater debt.

I think there is a lesson in the life and good works of Alfred Sloan which we as citizens should study carefully, for it relates to the future of all benevolent enterprises, and most particularly to the field of higher education.

The American university system itself, as it stands today, was largely developed out of gifts and bequests from individuals who, like Mr. Sloan, chose to share the fruits of their own achievement with all society. In the 50 years between 1880 and 1930, private gifts to education in this country amounted to more than $2,000,000,000 – the equivalent of several times that amount today. During this period, most of this giving came from large bequests, culminating in a peak of $140,000,000 in 1930.

Alfred Sloan, together with those who have benefited from his generosities, has reason to be thankful that he began his career at a time when it was possible for men of unusual ability to accumulate a substantial financial competence. I am afraid that even so able a man as he, had he been graduated from the Class of 1925 rather than the Class of 1895, would have found that the most productive years of his life would have left him far less to show for his efforts and little to share with the world.

Today's Tax Philosophy

Our current tax philosophy seems to say that the central government knows better than the individual what disposition to make of his worldly goods. Had this philosophy been in effect a generation earlier, the plight of higher education would have been far more serious than it is today. The real loser of course is not the individual who has attained financial success. Mr. Sloan could surely have managed to live as he wished to live without deprivation or want, as men do today who are in similar positions. The losers are those who would have benefited from the contributions of such men, not only in money, but in the personal interest that invariably accompanies a substantial gift.

The consequences of the current trend are obvious, yet I find myself unable, and unwilling, to see a complete answer in simply replacing these great human benefactions with funds from other sources. The problem is only partially financial. When a man such as Alfred Sloan establishes an institution, he gives it far more than money. The gift carries with it a portion of his character, his personality, his strength. Here is the difference between the wise and knowing heart of a father, attentive and sympathetic to his

(*Concluded on page 164*)

Response

Recognizing that science and education constitute the foundation of an advancing civilization, the significant question is asked: "What better investment can we, as a people, make than in education?"

by ALFRED P. SLOAN, JR.

AFTER all the kind things Mr. [Crawford H.] Greenewalt ['22] has said, it might be better if I remained silent. It is indeed difficult to say anything appropriate. On the other hand, I am not discouraged. I say that because I am not sure but what Mr. Greenewalt has put the cart before the horse – if I may be permitted for a moment to use a nonautomotive term. I am highly honored tonight on the occasion of your annual dinner meeting by both M.I.T. and its Alumni. But is it not true that it would be more appropriate if we, the Alumni, were to honor M.I.T.?

We take pride, and justly so, in the outstanding accomplishment of our Alma Mater. We know it has reflected expanded opportunity for our whole society. It has further enabled us to more effectively capitalize our individual opportunities. And that, it seems to me, suggests that something might be added. I mean that we, of the Alumni, must do our share in not only helping to maintain, but to advance, the high standards the Institute has created both in science and in education. To reach the top – whatever the enterprise may be – in an aggressive and ambitious society such as ours, is no light task. But to maintain that position is a far more difficult one. Self-satisfaction too often limits maximum effort. And leadership demands, and always will demand, among other things, the ability and imagination to discount future needs and events.

The future of M.I.T. depends not only on the aggressiveness of its Administration, as well as on the imagination of its Faculty in anticipating change, but also on support from you and the public at large, so essential in accepting the challenge of change. There never was a time in our history when education and its offspring – science – means so much in determining our economic and social progress and in underwriting our national security. Together they constitute the foundation of an advancing civilization.

The observations I have made are in no sense new. But some truths bear repeating endlessly – lest we forget!

While I have tried to do my part in supporting the needs of the Institute – and in that I take a certain amount of satisfaction – nevertheless I look upon it as an exchange or the payment of a debt rather than a matter of pride. There is one exception, however, on which I can take a certain amount of pride.

On the passing of the late Dr. [Karl T.] Compton, a most impressive memorial service took place in Cambridge. I was privileged to be present. On such occasions one is apt to turn to the retrospective. A recognition of the great contribution of Dr. Compton to our society and to the Institute in particular, flowed through my mind. As it did I realized that among the numerous scientific laboratories, the class rooms, the administration buildings, the beautiful library, and all the other impressive structures that constitute the Institute – although some bore the names of generous supporters – there was nothing to remind the future generations of students as to what they owed to the talents of Dr. Compton in the great privileges they were receiving. That caused me to suggest to the Institute that a new laboratory should be constructed to be designated –

"The Karl Taylor Compton Laboratory
for Nuclear Science and Electronics"

As we all know, the physical sciences was the area in which Dr. Compton was pre-eminent. The labora-

(Concluded on page 162)

F. S. Lincoln, '22

Among the honored guests at the annual Silver Stein dinner of the M.I.T. Club of New York, on November 14, were (in reading order): Thomas C. Desmond, '09, New York State Senator; Alfred P. Sloan, Jr., '95, Chairman, General Motors Corporation to whom the Club's Silver Stein was presented by Crawford H. Greenewalt, '22, President of E. I. du Pont de Nemours and Company; C. George Dandrow, '22, Vice-president, Johns Manville Corporation; and Technology President, James R. Killian, Jr. '26.

Graft Inquiry

The acceptance or rejection of grafts, by a body, is subject of research aimed at fostering understanding of repair of human body by transplanting "spare parts"

by FREDERIC W. NORDSIEK

GRAFTING of plants has served mankind usefully since the days of ancient Rome, and has been employed through the centuries to repair injured plants and also to propagate useful plants so that their desirable characteristics are maintained. If only grafting could be used with similar ease to mend injured human tissues or to replace lost members of the human body! But unfortunately at present it cannot, because man and the other higher animals differ extremely from plants in their ability to accept tissues or organs grafted from other individuals. Thus, in plants, grafts will "take" not only when they are transferred from one individual to another of the same species, but also when transferred between members of quite widely different species. In the human being, grafts will not take unless they come from another part of the same human body, or from the body of an identical twin.

Why this great difference? Basically plant tissues are quite tolerant in their acceptance of foreign materials, whereas the tissues of higher animals ruthlessly reject foreign materials. For example — admittedly an oversimplified example — consider that a nail driven into a living tree remains in place and does no damage. But a splinter entering human flesh quickly sets up inflammatory processes, and this inflammation expels the splinter.

The mechanisms for defense of higher animals against foreign materials are so powerful, and so delicately attuned, that they respond to the subtle chemical differences that exist between corresponding tissues of any two human beings (except identical twins). These individual chemical identities of human tissue appear to be as infinite in variety as the variations of human fingerprints. They are so subtle as to defy identification by ordinary chemical laboratory methods, although they are detectable by modern physico-chemical methods such as microelectrophoresis. Yet these individual chemical identities of human tissues are so definite that to any human body, even the corresponding tissue from another human body is just as foreign a material as tissue from an animal of some other species, or a piece of nonliving material. That is why the human body rejects grafts of tissue from another individual. The exception, as noted, is that grafts from one member of a pair of identical twins will take on the other member of the pair. This is possible because identical twins are, essentially, two halves of a single individual; therefore grafting of tissues from one to the other is equivalent to grafts made from one location to another of the same human body.

In certain inbred strains of laboratory animals, for example white mice, grafts may be readily transferred from one animal to another. This is possible because such beasts have been inbred for so many generations that any two animals are as alike as a pair of human identical twins. It is also true that in animals, embryonic tissue or cancerous tissue may sometimes be successfully transplanted, even to an animal of a different species. Such transplants are most apt to be successful if transferred to either the brain or the anterior chamber of the eye of the recipient animal; for reasons unknown these sites are especially receptive. Chances of success of this type of transplant can be further enhanced by administering cortisone to the recipient animal, or by irradiating it with x-rays. To encompass these exceptions, the question of transplanting tissues from one individual to another of the higher animals may be epitomized as follows: "In the higher animals, normal adult tissue may not be successfully transplanted from one individual to another, except between identical twins or their genetic equivalents."

This statement may baffle the reader who has read accounts of the apparently successful grafting of organs, such as the cornea of the eye or bones from the extremities, from cadavers to living persons. Grafts of this sort do not truly "take." They merely serve, temporarily, as a sort of scaffolding upon which the recipient of the graft may rebuild his own tissues by regeneration.[*1]

How does the animal organism exercise the exquisite discrimination that leads it to accept a tissue — say skin — transplanted from elsewhere on its own body, yet reject tissue from another individual? Some weight of evidence suggests that the mechanisms involved are immunological — are allied to the mechanisms whereby animals resist infectious diseases. Thus rabbits have been desensitized (made receptive) to skin grafts from other individuals by injecting them with an antigen prepared from the skin of the prospective donor. Although this procedure did not lead to completely successful grafting it did markedly delay the sloughing off of the graft. Cortisone or irradiation makes animals more receptive to transplants of embryonic tissue or cancerous tissue; and both cortisone and x-rays are known to depress immunity mechanisms.

[*1] For numbered references, see page 168.

But some authorities in the field of tissue transplantation hold that immunity mechanisms are not the answer to the body's resistance to grafts, and cite equally substantial experimental evidence to support their views. Investigators are vigorously studying the topic not only because of its theoretical interest but also because of its manifest practical importance. So far this research has been inconclusive. Indeed Dr. W. J. Dempster, an eminent British authority on skin grafting, has written, "The problem is so obscure that the widest research cooperation between experimental surgeon, clinical surgeon, serologist and geneticist will be required for its solution . . ."[2]

But despite this acknowledged paucity of fundamental understanding, grafting has empirical usefulness of broad scope in plants, and — within the limitations that have been sketched — in animals.

Grafting in Plants

Grafting of plants is based on the fact that, if freshly cut surfaces of woody perennial plants are held in firm contact and covered so that the cut areas do not dry out, the tissues readily grow together and unite into one continuous whole. Grafting is occasionally used to repair injuries, as for example when trees are harmed by storms. The principal value of plant grafting, however, is in the propagation of trees and shrubs so as to maintain or establish desirable characteristics by circumventing the uncertainties and delays inherent in the propagation through seeds.

The production of seeds for the propagation of annual plants, such as wheat or corn, involves tedious and expensive precautions to make sure that the seed-bearing plant is pollinated with pollen from a plant having desirable characteristics,[3] and also to make sure that the seed is not contaminated with seeds of undesirable varieties or of weeds. Even then there is always danger that mutations may occur during production or germination of the seed, with consequent loss of desirable characteristics. Furthermore many useful plant varieties are hybrids[4] and hybrids do not "breed true" when propagated by seeds, but revert toward the characteristics of the parent varieties.

As the propagation by grafting of woody perennial plants does not involve seed production, the uncertainties of propagation by seeding are circumvented, and, in addition, the delays involved in the growing of seed and in the germination of seed are avoided. Grafting for propagation purposes is carried out by grafting a branch from an adult plant known to have the desired characteristics (called the "scion") onto a trunk or root section (called the "stock") of a younger plant with unknown characteristics, or even with characteristics known to be undesirable. The blossoms and fruit on a grafted tree or shrub are the same as those borne by the plant from which the scion is taken. The tissues of the stock perform their regular functions of transferring moisture and nutrients from the soil, and of supporting the plant, but have no effect upon the blossoms and fruit. Thus, a single adult tree or shrub that produces blossoms or fruits of the desired size, color, and other characteristics may be used to produce a number of other plants, with total assurance that the fruits and blossoms of these offspring plants will be identical to those of the parent tree from which the scions were cut.

P. R. Cunliffe

Horticultural grafting has a number of other advantageous uses. Thus it may be used to hasten fruitfulness of orchard trees. Fruit trees do not bear during their early years, but branches of adult trees grafted upon a young trunk continue to yield fruit with adult vigor.

A particular advantage of horticultural grafting arises from the fact, already mentioned, that plants accept grafts from other species. Thus the plum, the peach, the apricot, the quince, and the cherry may readily be grafted on one another. In this way the orchardist can create trees designed to thrive under particular conditions. For example, if a small pear tree is desired because of limitations of available space, it may be created by grafting pear scions on a quince stock. Similarly, grafting may be employed to enable the growing of a desired fruit crop on whatever type of soil is available. Thus, plum trees favor "heavy" soil, peach trees do best on "light" soil. Plum trees that prosper on light soils are made by grafting plum scions on peach stocks; the reverse procedure is used to make a peach tree adapted to heavy soil. Similarly, grafting may be used to produce horticultural curiosities, such as a fruit tree bearing apples, pears, and peaches, or a rose bush bearing blossoms of several different varieties.

Human Grafting

Skin grafting, archetype of the procedure in human beings, has been practiced for centuries. It is invaluable whenever an area of skin, too large to be replaced by this tissue's natural regenerative powers, is destroyed. Then pieces of skin, skillfully sliced from an unharmed section of the patient's body, are transferred to the injured area; the borrowed skin is replaced by regeneration taking place at the donor site. Even large areas may be repaired by a technique called the "sieve" graft. The skin to be transplanted is cut in perforated form, leaving islands of skin behind. These islands form a base for regeneration of skin that rapidly covers the donor site. The sieve of skin transplanted to the injured area regenerates enough skin to cover that area.

But transplantation of parts of the patient's own body is no longer limited to the skin. Now bone, cartilage, and mucous membrane are also successfully grafted, thanks in large measure to advances in plastic surgery growing out of the rebuilding of service men maimed during and since World War II. Jaw bones are made from ribs; eyelids, from neck tissue; lips, from the mouth lining; nostrils, from ear lobes.

Twin-to-Twin Grafts

On a number of occasions the knowledge that grafts may be successfully made from one member to the other of pairs of identical twins has found practical application. In the fall of 1955, U.S. Air Force medical officers located (in the Army in Korea) Charles Madeira, the twin of airman Rodney Madeira, who had been gravely burned in an accident at Bordeaux, France. Both twins were flown to the Air Force hospital at Wiesbaden, Germany, where, with the consent of Charles, large areas of his skin were successfully transplanted to burns on Rodney's body. On at least two previous occasions (in 1952 and in 1954) the Army Medical Corps has persuaded identical twins to donate skin to badly burned brothers, each time with successful outcome.

Even more dramatic was the recent transplanting of a kidney from one identical twin to another at Boston's Peter Bent Brigham Hospital.[5] Both kidneys of Richard Herrick had atrophied, so that ordinarily he would have been doomed. The fact that Richard's brother Ronald was his identical (not fraternal) twin was confirmed by checking the brothers' hospital birth record and noting there had been a single placenta; by finding that their blood types are identical (by eight different blood-grouping sytems); by determining that they both "taste" phenylthiocarbamide (a characteristic inherited according to the Mendelian laws),[6] and finally by trying small reciprocal skin grafts, which "took." Surgical transfer of one of Ronald's kidneys to Richard was then undertaken. A year later the transplanted kidney was reported to be functioning normally, and both young men were well.

Grafting between Non-Twins

Although it is known that normal adult human tissue does not really "take" when grafted onto another person who is not an identical twin, such grafting is widely practiced. Thus skin, whether from a live donor or a cadaver, is considered to provide a superior temporary protective covering for burned or otherwise flayed areas, even though such grafts are ultimately sloughed off. The Barnes Hospital at St. Louis, Mo., maintains a skin bank, stocked with skin from cadavers, for just this purpose. Refrigerated at four degrees C., the skin remains usable for three weeks. Skin that needs to be banked for longer periods is frozen and held at —79 degrees C., under which condition it keeps for several months. Skin from this bank is credited with saving the lives of numerous critically burned accident victims.

Tissue Banks

Besides skin, tissues that have been transferred from one human being to another, with varying degrees of success, include bone, cartilage, fascia, corneas, nerves, blood vessels, and tracheas. Transplanting of tissue having a high proportion of inert matter with a low proportion of living cells, such as bone, cartilage or fascia, is relatively easy. The cornea of the eye is an example of a tissue consisting mainly of living cells; the outcome of corneal transplants is at best uncertain. In all instances, tissues of both high-cell and low-cell types atrophy sooner or later after transfer, but are nevertheless useful because, while they last, they provide a nonreactive scaffolding for invasion by cells of the recipient. In other words, they serve as a matrix in which the recipient may reconstruct the missing or injured organ by the natural regenerative powers of his own tissues.

Eye banks that stock corneas exist in several major cities. Since 1949, New York City has had a blood-vessel bank. The armed services have been in the forefront in the banking of spare parts for the human body. Thus, when two sailors perished instantly of broken necks in an automobile accident not far from the Naval Medical Center at Bethesda, Md., early in May, 1956, Navy officials persuaded the families to permit parts of the bodies to be taken for the center's tissue bank. Operating so that areas of the bodies visible at the funeral remained unmarred, doctors collected blood vessels, fascia, bone and skin – enough for an estimated 75 patients. This bank freeze-dries its stored tissue. Up to the time of the episode recounted, it had collected tissues from 104 individuals and distributed the tissues throughout the United States for use with more than 1,000 patients.

Transplanting Nonhuman Tissue

Some use has been made of nonhuman tissue to repair defects in the human body. Thus, bone from young cows shows promise of usefulness in remedying human bone injuries, again serving only as a scaffolding around which the patient's own bone regenerates. This observation stimulates the question: Could not nonbiological materials be similarly used? The answer apparently is "Yes," as tubing woven of synthetic fibers – orlon, dacron, nylon, or Vinyon-N – has been used to replace segments of major human blood vessels. One middle-aged Chicagoan is reported to be thriving with a foot and a half of his femoral artery replaced by dacron tubing.

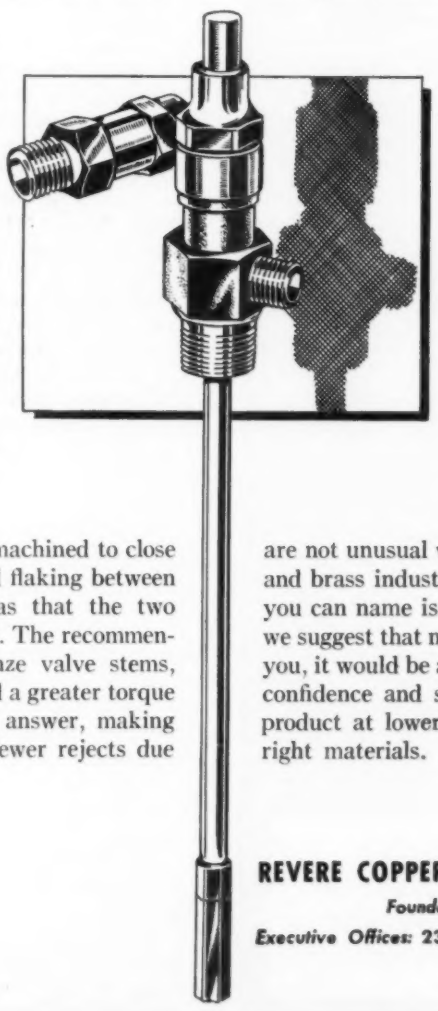
(Continued on page 166)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

In making gas pressure-reducing valves and relief valves for hot water tanks, a famous manufacturer has to drill brass rod deeply. Originally the rod was free-cutting brass. When we had the opportunity to study the operations in the shop it seemed evident that Revere's Deep-Drilling Brass Rod should offer some economies. When drilled, this alloy produces very small, easily cleared chips, much smaller than free-cutting brass. The latter is excellent for most applications, particularly for external machining, or for shallow drilling, but for really deep holes, deep-drilling brass is superior. So the customer agreed to try it. The results were most satisfactory. The shop foreman reported that tool life was increased over 200%. In addition, it is possible to bore one item with a single operation, against the former practice of withdrawing the drill three times in order to clear the chips.

Another interesting experience with the same manufacturer involves a high-pressure gas valve, with a cast brass body and a brass rod stem, both machined to close tolerances. There was galling and flaking between stem and seat. Our analysis was that the two brasses were too close in hardness. The recommendation: switch to arsenical bronze valve stems, which have a higher hardness, and a greater torque strength. This proved to be the answer, making possible a better product, with fewer rejects due to trouble at the seat. The more suitable alloy costs more per pound, but saves money in the end.



Here is a third example of our work with the same company. It was designing a new temperature-pressure relief valve for hot water tanks. The original model, hand-made for test purposes, had been machined out of solid hexagon brass rod, one inch outside diameter, and over half the weight had gone into scrap. It was recommended that on a production basis a Revere high-leaded brass tube be used, hexagon outside, round inside. A trial order of only 2,000 pounds immediately proved itself.

The customer reported that though the tube costs more per pound, he buys less weight per foot, machine time is reduced substantially, and a much better machined surface is obtained. The latter is extremely important on the inside of the valve, which is machined to a seat.

These examples of the wisdom of paying more per pound in order to make a better product and save money in addition are not unusual with Revere. Not only the copper and brass industry but practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the right materials.

REVERE COPPER AND BRASS INCORPORATED

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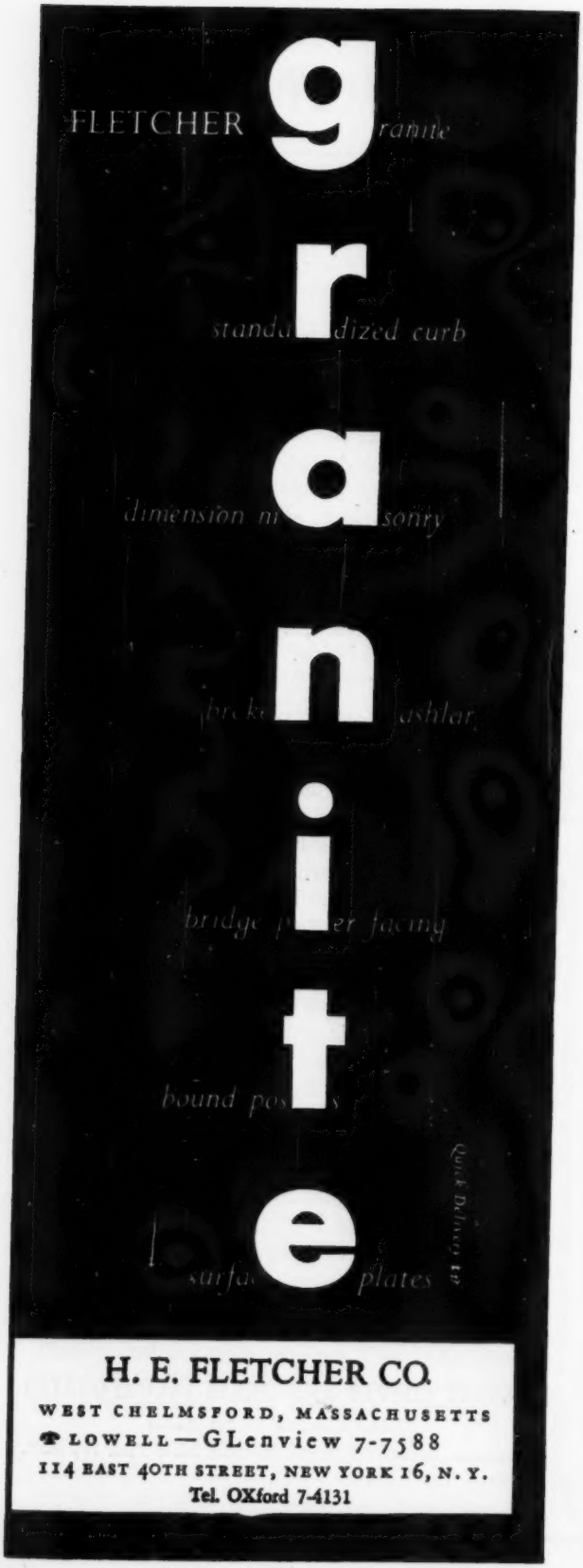


TREND OF AFFAIRS

(Concluded from page 148)

topics are still of major importance to the Department.

Faculty members for the Department have numbered from 18 (in 1952–1953) to 20 (in 1955–1956) with an estimated 23 for the current school year. The increased enrollment for the academic year, 1956–1957, is expected to take place mainly in the junior, senior, and graduate courses. This increase is due in part to the greater size of the Junior Class and in part to the higher percentage of students who take mathematics subjects beyond the first two years. An important factor in this increase is a large increase in the number of majors in Electrical Engineering and Physics, many of whom take a great deal of mathematics.

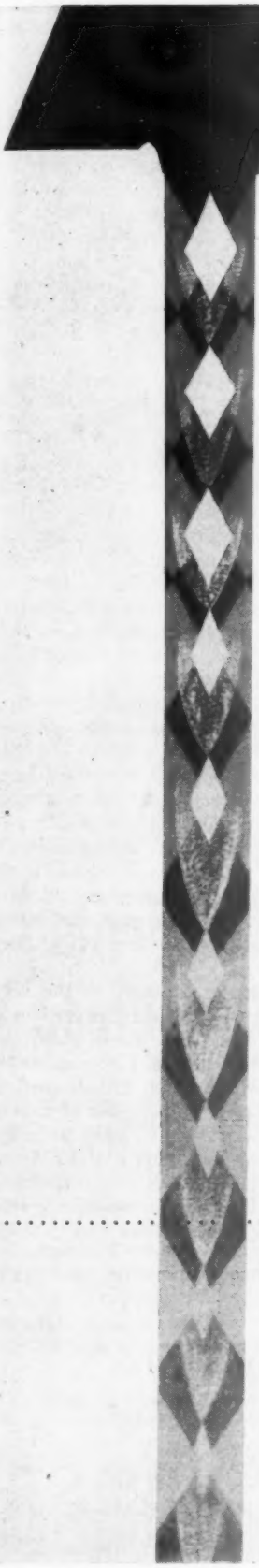
Space: In the summer of 1955 the Institute converted two classrooms into four new offices for the Department and at the same time altered some of the first floor offices enabling the Department to set up a new undergraduate mathematics office. These changes have proved most helpful to the Department this year, and the Department appreciates very much the generous assistance of the Institute in furnishing this additional space. With the increased staff which the Department hopes to appoint for next year, four more new offices will be needed. The request for this additional office space has been made. The Department expressed regret that its need for additional office space comes at the very time when the total space needs of the Institute are also very acute.

Library: In last year's report, the main library needs of the Department were summarized as follows: (a) a systematic plan for replacing lost books; (b) the binding of unbound mathematics periodicals; (c) enough additional library staff to allow one member's time primarily for the mathematics collection; (d) a modification in the cataloguing of new books; (e) additional display racks for current issues of journals.

Some time ago the Department prepared a list of unbound journals, arranged in order of preference, and reported that significant progress has been made on the binding of these. Also progress has been made on some of the other items. Recently representatives of the Department met with the new Director of the Library and discussed in detail the various needs listed above. In the opinion of the Department the discussion was extremely fruitful. Explicit plans were discussed to help meet the needs. The Department is very much pleased with these plans and feels very hopeful that substantial progress will soon be made on the remaining items.

The Department appreciates very much the support which the Administration has given to the fulfillment of these major needs.

The report of the Visiting Committee (dated February 9, 1956) was received in the President's Office on April 13, 1956, and was received for publication in The Review, after suitable editing, on October 25, 1956.



GUIDED MISSILE RESEARCH and DEVELOPMENT

A major guided missile research and development program has several significant characteristics that are of particular interest to the scientist and engineer.

First, it requires concurrent development work in a number of different technical areas such as guidance and control, aerodynamics, structures, propulsion and warhead. Each of these large areas in turn contains a wide variety of specialized technical activities. As an example, digital computer projects in the guidance and control area involve logical design, circuit design, programming, data conversion and handling, component and system reliability, input-output design, and environmental and mechanical design.

A second characteristic is frequently the requirement for important state-of-the-art advances in several of the technical areas. For instance, the supersonic airframe needed for a new missile may necessitate not only novel theoretical calculations, but also the design and performance of new kinds of experiments.

A third characteristic of missile development work is that such close interrelationships exist among the various technical areas that the entire project must be treated as a single, indivisible entity. For example, what is done in the guidance portion of the system can affect directly what must be done in the propulsion and airframe portions of the system, and vice versa.

These characteristics make it clear why such work must be organized around strong teams of scientists and engineers. Further, for such teams to realize their full potential, they must be headed by competent scientists and engineers to provide the proper technical management. And finally, all aspects of the organization and its procedures must be tailored carefully to maximize the effectiveness of the technical people.

Principles such as these have guided The Ramo-Wooldridge Corporation in carrying out its responsibility for overall systems engineering and technical direction for the Air Force Intercontinental and Intermediate Range Ballistic Missiles. These major programs are characterized by their importance to the national welfare and by the high degree of challenge they offer to the qualified engineer and scientist.

Openings exist for scientists and engineers in these fields of current activity:

Guided Missile Research and Development
Aerodynamics and Propulsion Systems
Communications Systems
Automation and Data Processing
Digital Computers and Control Systems
Airborne Electronic and Control Systems

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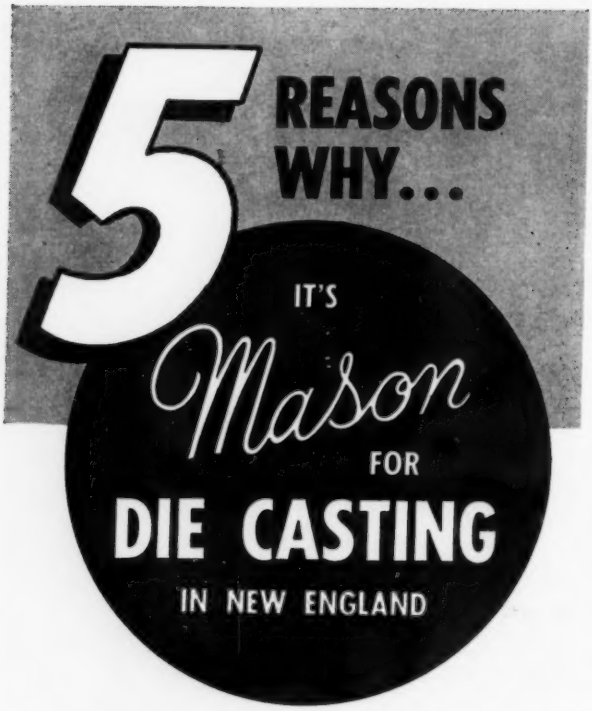

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RESPONSE

(*Concluded from page 155*)

tory is now under construction. It will soon be an accomplished fact. It will serve not only to honor and to perpetuate Dr. Compton's name in the Institute's scheme of things, but as an incentive in the years to come to all of us to carry on and to expand through scientific research, our knowledge of the wonders that nature still has in store for us.

In the growing need of financial support of our institutions of higher learning, the alumni groups appear to be taking increased responsibilities. It is true that while society as a whole profits, the Alumni benefit more directly. . . .

When I think of the great need that exists, I am reminded of an economic formula:

Production equals consumption plus savings.

That means that we must put our savings back into the economic stream to maintain the level of production. But does not the formula also imply that the more efficiently we can do so, the more we shall be able to increase our productivity and hence raise our standard of living? I ask you: "What better investment can we, as a people, make than in education?" The opportunity is great wherever we look. It never was greater. New discoveries flowing from research, open up new vistas of further progress. . . .

M.I.T. is fortunate in many ways. It has an enviable position. It has an ambitious and imaginative leader in Dr. [James R.] Killian, [Jr., '26]. He has not only advanced the status of the Institute on all fronts, but I am sure he will carry it to far greater heights in the years to come. He has our confidence. He has our support. We have a faculty of outstanding leaders in their respective areas. We have a loyal and appreciative Alumni. So, it seems to me, we have all the component parts of a bright and constructive future, insuring an expanding contribution to science and technology.

These few words bring me back to the occasion this evening. I thank you one and all for the honor you have bestowed upon me, emphasized by the award of the Club's Silver Stein. I appreciate the remarks of Mr. Greenewalt and Dr. Killian. And, may I add this: The time comes to every one of us – and it has come to me – when we have more to look back on than to look forward to. Such is the rule of life! For that reason I shall cherish this occasion more than I can tell you. It gives me something more to look back on. And for that – I have you to thank!

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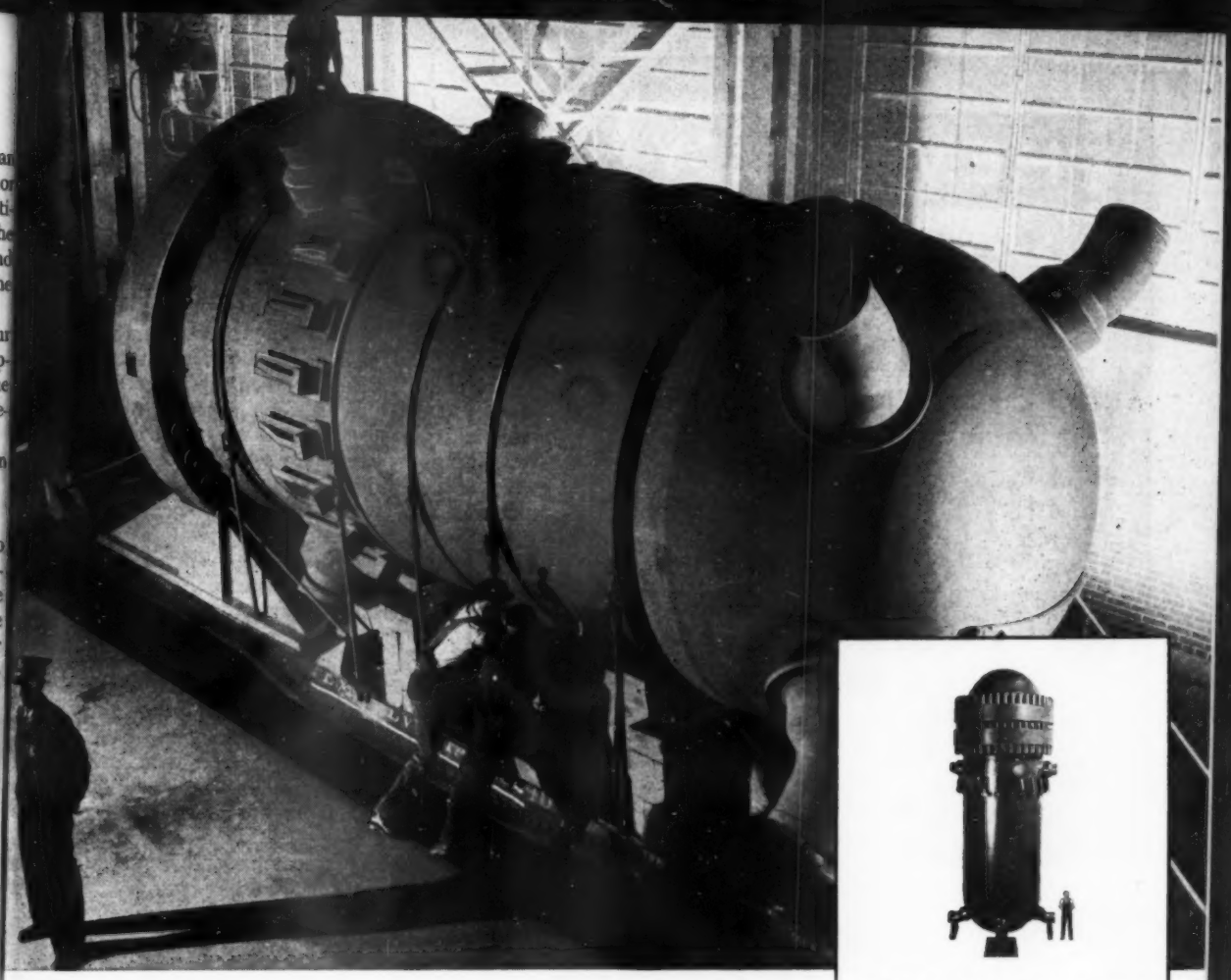

Model of the Shippingport reactor vessel with removable head in place. The completed vessel stands 3 stories high, weighs 235 tons, with some large parts machined to tolerances approaching those obtained in watch-making. 217 tons of water will pass through its nuclear core every minute —at pressures in excess of 2000 psi.

C-E delivers the world's heaviest unit of nuclear power equipment

The photograph shows a milestone on the frontier of peacetime atomic power . . . the shipment of a reactor vessel designed and built by Combustion Engineering for America's first full-scale nuclear power plant. This huge vessel — which houses the nuclear reaction within steel walls 8½ inches thick — is the heaviest unit of atomic power equipment ever built. It was shipped on a special 9-car train and is being installed in the Shippingport (Pa.) Nuclear Power Station, designed by Westinghouse Electric Corporation under contract with the A.E.C. The station will be operated by the Duquesne Light Company and is scheduled to go into service in 1957.

New machines and new techniques were developed to make possible a manufacturing precision never before achieved in a unit of this size. The final machining operation required two months on one of the world's largest boring mills. It involved the use of new optical techniques to align matching machined surfaces to the extremely high degree of accuracy specified. C-E's 15-million-volt betatron searched for defects as small as a ⅛-in. length of toothpick in welded joints up to 10 inches thick.

Combustion is actively engaged in many nuclear projects, including the design and manufacture of a complete reactor system for a submarine. Its resources of highly specialized personnel and facilities for nuclear work will enable it to play as important a role in the future use of atomic fuels as it has long played in the generation of power from conventional fuels.

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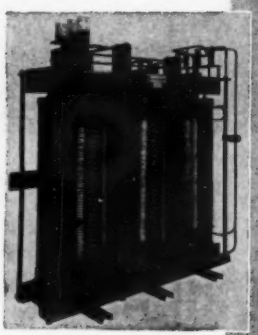

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ENCOMIUM

(*Concluded from page 154*)

family's needs, and the cold, impersonal hand of the stranger, or the bureaucrat.

It is individual philanthropy which has provided the great enrichment of our culture. The state, when it turns to such matters, must tailor its program to the general level, to the common denominator. And necessarily, it deals with its problems in a dispassionate and impersonal way. Private individuals, on the other hand, can and do undertake projects which would be impossible, or even improper, for government. Our private educational institutions, our art galleries, our museums, our great symphony orchestras, and many of our libraries have been made possible by large private gifts – gifts not only of money but of personal enthusiasm and dedication.

As the opportunities for private generosity are gradually worn away, we face, I am afraid, the possibility that our moral and spiritual standards will be subjected to a similar erosion, and that I know will affect both he who gives and he who receives. Certainly there is spiritual satisfaction in giving – in the discharge of an obligation, in sharing with others, in the creative contribution which brings into being something that would not otherwise exist. And for the beneficiary of a generous act there is the precept and example to conduct himself with the same generosity to others. His own expression of charity may not be in the same form or on a commensurate scale, but what he cannot reciprocate in kind he may more than repay in kindness. For the act of charity in any form brings with it an inspiration to do likewise within the limits of our ability.

This is the priceless heritage that we stand to lose. Perhaps, in some fashion, the dollars can be forthcoming. But the character of the individual donor which imparts a far greater purchasing power cannot be found elsewhere, and the impulse to further generosity on the part of the recipient will be gone.

The accomplishments of men like Alfred P. Sloan in their lifetimes and in their memory have created great and lasting benefits far outweighing anything they retained for themselves. It follows that restrictions which limit the individual must inevitably limit the public good. I cannot believe that the people of the United States will agree permanently to suffer so great a loss.

Stein Presentation

It is my privilege tonight to tender to Mr. Sloan a token of appreciation and recognition. The Silver Stein Award of the M.I.T. Club of New York is given in honor of conspicuous services to the Club, the Institute, or to the public welfare. Mr. Sloan, in the opinion of the responsible committee, qualifies preeminently in all three classifications.

The Stein itself is here. It seems, unhappily at the moment, to be empty. There is nothing empty, however, in the honor which it represents, and it is with the greatest of pleasure, Mr. Sloan, that I present you – with the admiration, the esteem, and the affection of all your associates in M.I.T. affairs – the Silver Stein trophy.

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Physicists:

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These cables are for aircraft, jetcraft or missile installations where air friction or engine temperatures are high.

BIW cables are used for electronic applications for fuel gauge wiring, fire detection circuits and other uses where dependable performance under adverse conditions is vital.

These 600 volt power and lighting cables for aircraft are designed to operate continuously at a temperature of 200°C. They have unusual resistance to corrosive vapors, acids, solvents and hydraulic fluids. They will not fracture at —80°C of cold and are highly resistant to flame and abrasion.

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Description	Flexible silver plated copper conductor.	Flexible silver plated copper conductor.	Flexible silver plated copper conductor.
Insulation	Teflon tape	Pure teflon—for continuous operation at 400°F, intermittent temperature to 500°F, flexibility as low as —65°F.	Pure teflon—for continuous operation at 400°F or 250 hours at 500°F. Insulation deteriorates at 600°F. Flexible as low as —65°F.
Covering	Saturated fiberglass braid	Silicone varnish, double saturated fiberglass	Double saturated fiberglass impregnated with teflon and heat sealed.
Color	Color coded under shielding.	Light tan standard; or black, red, orange, yellow, green, blue & brown.	Brown standard; or white
Printing	All coverings may be printed with identifying symbols where a large number of circuits are in use.		
Current Rating	Send for detailed tables for current ratings.	Send for detailed tables for current ratings.	Send for detailed tables for current ratings.
Shielding	Either tinned or silver plated copper shielding provides 85% coverage.		

These cables are approved under specification MIL-W-7139A, and their performance exceeds minimum test requirements of the specification listed as follows:

Dielectric Test:
After suspension for five hours in 5% salt water solution, sample shall withstand 1000 volts RMS for 5 minutes.

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120 hours baking at 500°F followed by water immersion for 20 hours and subjected to the dielectric test.

Cold Bend Test:
1 hour at —55°C followed by flexing around a 3" mandrel at this temperature and subjected to the dielectric test.

Flammability Test:
The specimen shall not burn after 30 second application of a Bunsen Burner flame. The insulation or outer braid shall not fall from the wire or expose the copper conductor, and shall leave a firm semi-abrasive covering to afford physical separation capable of withstanding a maximum operating voltage of 500 volts RMS when applied between the conductor and a metal plate. Care shall be taken not to bend the specimen while placing it on a metal plate.

Surface Creepage Test:
After subjection to 95% RH for 20 hours at 120°F the surface shall withstand a voltage of 1400 volts D.C. on 1¼" of the surface with less than 2 milliamperes leakage.

Insulation Resistance Test:
After immersion in water for 48 hours the insulation resistance measured on a galvanometer is in excess of 5000 megohms per M ft. with no measurable change between 12 hours and 48 hours.

Oil and Solvent Absorption:
Sample is immersed in lubricating oil, gasoline, salt water, ethylene glycol, alcohol, carbontetrachloride and Hydrolube hydraulic oil for a period of 20 hours after which it is subjected to the dielectric test.

Capacitance Test:
The capacitance at 1,000 cycles #20 gauge measured 66 mmf/ft. after 24 hours with no measurable change after 48 hours.

For Complete Details Send For BIW Ten-Page Catalog

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65 Bay Street, Boston 25, Mass.

GRAFT INQUIRY

(*Continued from page 158*)

Grafts as Tests

It was previously mentioned that the fact that Ronald and Richard Herrick – the twins who shared Ronald's kidney – were identical rather than fraternal twins was clinched by reciprocal skin grafts. Such swapping of skin as a test of the type of twinning has some general usefulness. As certain degenerative disorders and mental deficiencies are considered to be hereditary, they may be expected to develop in both members of identical twins. Therefore if such a condition appears in one of a pair of twins, it becomes of value to know whether the siblings are identical or fraternal, as a means of forecasting the future of the other member of the pair and taking such preventive measures as are available, if the twins are identical. Reciprocal skin grafting has been applied for this purpose as a means of establishing categorically whether or not a pair of twins are identical or merely fraternal.[7]

A rather startling application of skin grafting as a test is its use to weigh claims of parthenogenesis, or "virgin birth," in the human being. It is established that in fish, fowl, and rabbits the female can reproduce without co-operation of the male. Is "life without father" possible in the human being? This question has recently become a focus of sensational public interest in England. Several newspapers reported medical discussions of the topic and one, the Sunday *Pictorial*, urged women who believed they had experienced this phenomenon to come forward in the interest of science.

The offspring of such a birth would have to be a daughter. A preliminary test of the parthenogenesis claim is determination that mother and daughter have identical blood groups; a final test is successful reciprocal skin grafting. As of mid-1956, one Englishwoman and her daughter had satisfied all of these criteria!

Future of the Field

Much research is afoot on the subject of grafting of human and other animal tissues. Indeed the field has gained such stature that it now has its own technical journal[8] and has been the subject of weighty scientific conferences.[9] Studies in tissue transplantation range from purely empirical efforts to improve the mechanical techniques of skin grafting, to profound searches into the mechanisms whereby the body rejects or accepts grafts. Thus, in time, these investigations may be hoped not only to advance repair of the human body by transplantation of "spare parts," but also to clarify the body's immunity mechanisms. More knowledge of human immunity mechanisms is urgently needed. Such insight might explain why the human body resists grafts – and perhaps provide means for circumventing this resistance. It might also advance understanding and control of infectious diseases. Perhaps it might even explain why, for a time, cancer may remain quite localized in one human individual whereas in another it spreads like wildfire.

(*Concluded on page 168*)

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Discovery of
URANIUM-233
TRITIUM
CARBON-14
IRON-59
IODINE-131

Discovery of the antiproton and antineutron

Artificial production of mesons

These accomplishments in pure and applied science are widely known. To this impressive list, scientists and engineers at the Laboratory's Livermore site are making equally important contributions in the fields of nuclear weapons design, nuclear rocket propulsion, controlled thermonuclear energy (Project Sherwood) and high current accelerators.

What you can do to help add to these accomplishments is limited only by yourself—your *ability* and your *interest.*

For the University of California Radiation Laboratory is managed and directed by outstanding scientists and engineers.

These men are your "team-mates"... offering pioneering knowledge of the nuclear field and the newest, most expansive laboratory facilities. Here—where new ideas and techniques are traditional—initiative is constantly encouraged and developed.

IF YOU are a **MECHANICAL** or **ELECTRONICS ENGINEER,** you may be involved in a project in any one of many interesting fields, as a basic member of the task force assigned each research problem. Your major contribution will be to design and test the necessary equipment, which calls for skill at improvising and the requisite imaginativeness to solve a broad scope of consistently unfamiliar and novel problems.

If you are a **CHEMIST** or **CHEMICAL ENGINEER,** you will work on investigations in radiochemistry, physical and inorganic chemistry and analytical chemistry. The chemical engineer is particularly concerned with the problems of nuclear rocket propulsion, weapons and reactors.

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GRAFT INQUIRY

(*Concluded from page 166*)

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The references given above are intended merely to serve as examples of available medical literature.

EDUCATION OF THE UNCOMMON MAN

(*Continued from page 151*)

in Anne Roe's recent study of the backgrounds of 64 eminent scientists, most of whom, she discovered, did not decide on their vocations until their junior or senior year in college. Presumably these men, who later reached the first rank of the nation's physical and social scientists, explored thoughtfully during most of their undergraduate education. They sought successfully for a field in which they could take a consuming interest. And in that field they became so absorbed that it commanded their talent, their time, and their unceasing work during their adult lives. To these men the freedom to explore during their undergraduate years evidently led to a motivation that is of prime importance to all uncommon men. And it is in achieving such motivation that a synthesis of freedom with discipline must permeate the methods of education.

Good teaching is usually the source of this kind of motivation in students, no matter when the motivation develops. The experience of the research chemist, Robert E. Hulse, can testify to that fact. Dr. Hulse recently attributed his lifelong interest in chemistry to a class in high school. Commenting that as a boy he had no interest in chemistry, he went on to say: "I was in my last year in high school expecting to study civil engineering at Rutgers when I took the regular

(*Continued on page 170*)

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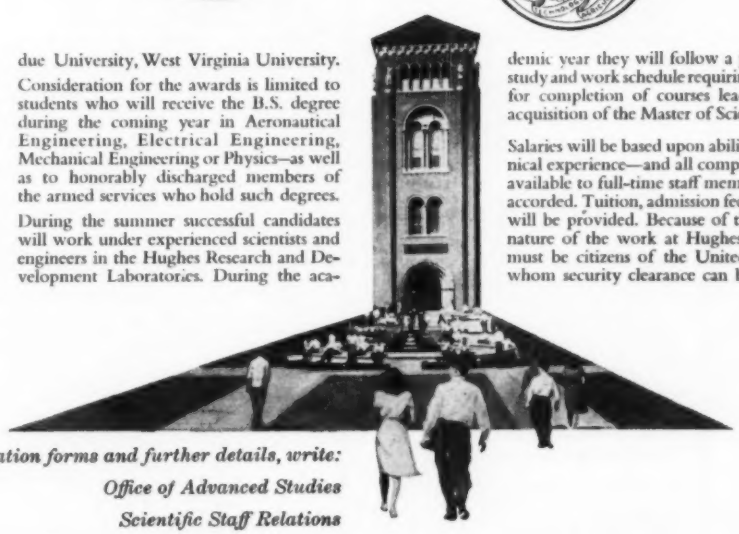

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EDUCATION OF THE UNCOMMON MAN

(*Continued from page 168*)

high school chemistry course. The teacher we ha made it all sound so very interesting that overnigh I knew that I wanted to learn more."

Uncommon teaching methods must be devised fo the uncommon student, else he emerges from hi school and college years unchallenged by the exper ence. This can have two harmful effects. The gifte student will not have reached his limit of intellectua capacity for absorbing and digesting academic mate rial. In so far as he fails to do this, just so much i society denied the benefits later on of his contribu tion. The other harmful effect is on the student him self, for he never feels the impact of hard intellectua work. "Coasting" is one of the student phrases usec to describe a curriculum too easy for the student wh "never has to crack a book" and yet receives passing grades or even honors. Professional life later on in evitably challenges capable people to the last ounce of their intellectual and sometimes their physical strength. Therefore, whatever the subject matter and however large the classes, the college and profes sional school must be flexible enough to offer assign ments and corresponding rewards sufficient to bring out the very best effort of our talented students. Pos sibly one reason for the ability of the so-called pres tige colleges to attract excellent students is that they have reputations of meeting the uncommon studen with the challenge he deserves.

The teaching profession in general, whether in en gineering, art, or architecture, is now sifting from the curricula the myriad skill courses that have been cluttering up professional education. Today emphasis is being placed on fundamental principles and rela tionships. Value judgments that were avoided as un scientific and subjective are encouraged, at least in the social sciences, and in the arts. Principles are acquired for the solving of original problems rather than for drill problems, the answers to which are found in the back of the book. Laboratory exercises have been too often a dull experience involving little more than filling in the blank spaces of an orderly procedure perfected years before. Studio exercises and architectural problems formerly consisted of copying with care the preconceived arrangement and order of an instructor. Today, imagination, creativity, and the power to act are the three most important

(*Continued on page 172*)

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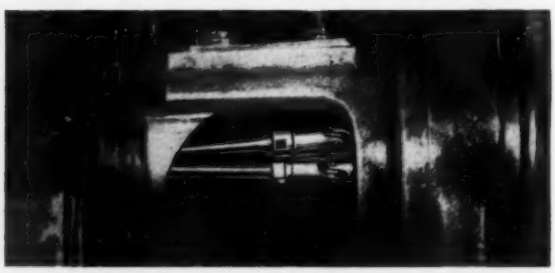

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EDUCATION OF THE UNCOMMON MAN

(*Continued from page 170*)

ingredients that will transform a run-of-the-mill educational experience into a real challenge to the capable student.

These ingredients have to be absorbed in terms of student-centered and project-oriented exercises in which intellect, interest, and enthusiasm are demanded to the limit of the capacity of those participating. The project method has meant many things in American education — from Rudolf Weaver's architectural program in the 1920's at the University of Florida to the case book methods of schools of law and business. The organization of source materials, whether from laboratory or library, is left to the student. The text, if any, answers the purpose of anticipating experiences which will be met later on — and not of a decalogue to be memorized or a chart to be followed. Inductive logic is relied upon. Generalizations based on experiment and observation are encouraged. The unity of knowledge, the synthesis of related factors is stressed. The talented student responds joyfully to an academic atmosphere of freedom and accent on self-reliance and resourcefulness. The mediocre student drags his feet, wonders what it is the instructor "wants." At this point the instructor knows, if he didn't know before, who his bright students are and what to do for them. The age-old academic dilemma of slow and fast sections is no dilemma at all, for the choice need not be an either-or-proposition. As a rule, there is no reason why the bright students in a class of mixed talents cannot be intrigued into pursuing the subject matter more thoroughly and more painstakingly than the mediocre student.

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(*Concluded on page 174*)

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EDUCATION OF THE UNCOMMON MAN

(*Concluded from page 172*)

human studies. To be adequate, higher education must redress this balance. The humanistic social sciences are steadily adjusting themselves to the scientific, social, shrunken and dynamic world of the Twentieth Century. They now include within themselves all human experience, not only that of the Western peoples; they embrace new disciplines and new combinations of old disciplines; and they function as ways toward understanding human behavior not only as the means to individual spiritual enrichment."

The uncommon student requires an uncommon college teacher – one who will inspire him toward intellectual development and creative endeavor for the rest of his life. This requirement I would put above all others. And although there are many who will argue to the contrary, the best teacher is likely to be one who has performed, and continues to perform, creative work himself – in his teaching, his writing, his research, his consulting.

Elliott Dunlap Smith has this to say about the character of the teacher and of his teaching:

> Good teaching can combine discipline with fundamental originality. It can face the student with a genuine perplexity that causes him to escape from stereotypes and to break through routine to fundamental thought. It can cause methods as well as data to cease to be inert; to become flesh and dwell within the student; to be material which he uses and remolds under a vigorous, trained and flexible style that is truly his own. It can make his professional style so fundamental that it strengthens his power in every field, not merely in that of his university study. It can give him confidence to meet the perplexities of this world unabashed as a citizen as well as a professional man. In a word, professional education, by its teachers and by its teaching, should develop capacity for fundamental originality in learning from experience and in meeting the problems that life brings.

That "capacity for fundamental originality," which good teaching can help to instill in the gifted mind, is the essence of creativity – of the creativity that Sir Herbert Read called the only adequate compensation for the conformity and the suppression of individuality which community life requires today. It is a requisite for the uncommon teacher, if the teacher is to help his students to become uncommon men and women.

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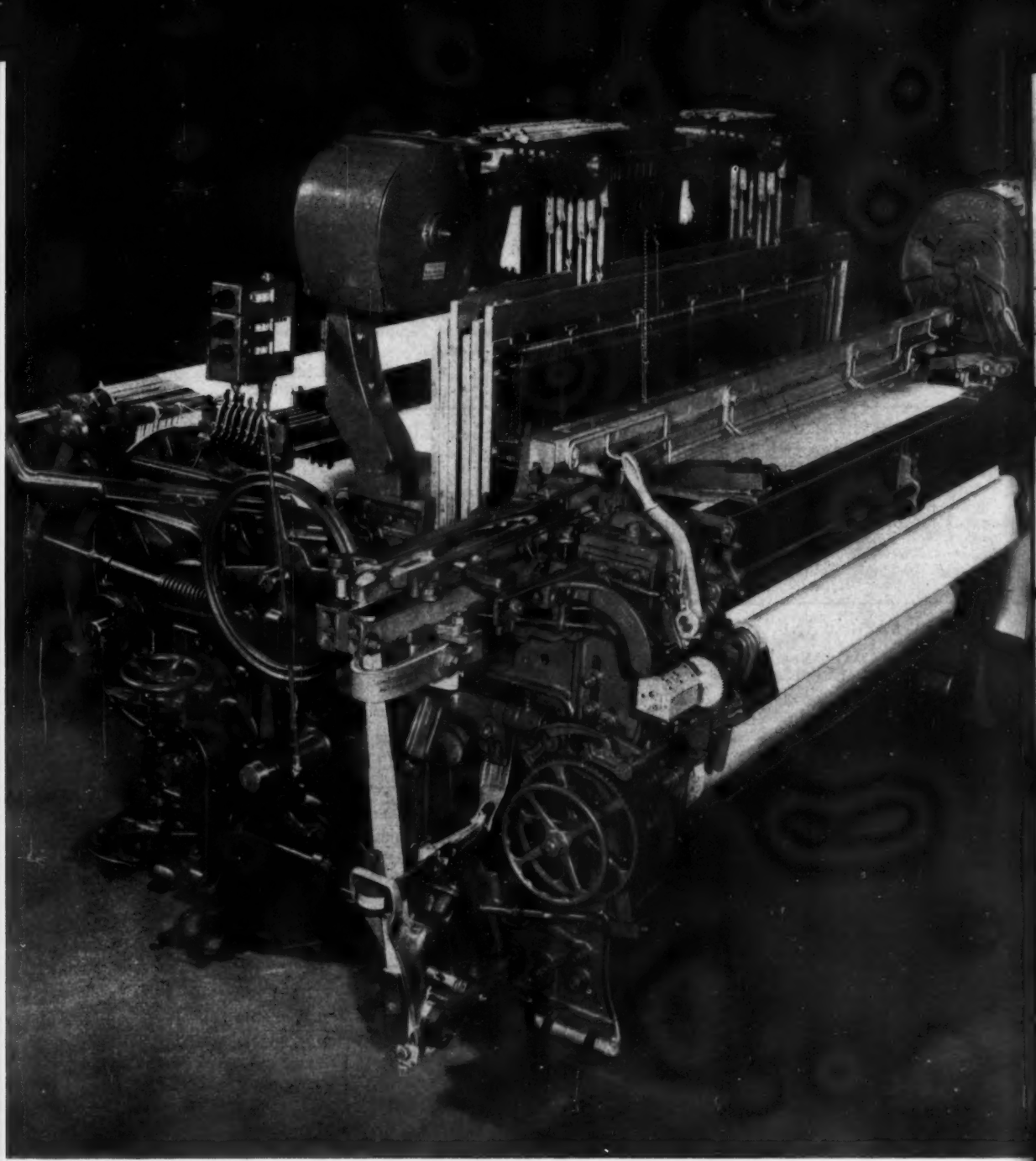

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